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IDENTIFICATION OF VOLATILE CONTAMINANTS OF SPACE CABIN MATERIALS

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FOREWORD

This study was conducted by the Dayton Laboratory of the Monsanto Research Corporation, 1515 Nicholas Road, Dayton, Ohio 45407, under Contract No. AF 33(615)-1779 with the Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio. This research was conducted as part of the joint Air Force/National Aeronautics and Space Administration Program on Space Cabin Toxicology. Materials used in this study were supplied by the Manned Spacecraft Center, NASA through McDonnell Aircraft Corporation. The principal investigators for the Monsanto Research Corporation, under the project leadership of Mr. John V. Pustinger, Jr., were Mr. F. Neil Hodgson and Mr. William D. Ross. The contract was initiated by the Toxic Hazards Branch, Physiology Division, Biomedical Laboratory, in support of Project 6302, "Toxic Hazards of Propellants and Materials," Task 630204, "Environmental Pollution." The technical monitor of the contract was Captain John A. Jurgiel of the Toxic Hazards Branch. This study was started in June 1964 and was completed in September 1965.

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This technical report has been reviewed and is approved.

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ABSTRACT

Fifty-five candidate materials for space cabin construction were stored for 30, 60 and 90 day periods at 23-25°C, and 20-40% R.H. in environments of air at a pressure of one atmosphere and oxygen at 5 psia. The composition of the gas-off products were determined by mass spectrometry and gas chromatography.

Considerable amounts of gas-off products were detected from candidate materials prepared immediately prior to testing, e.g., coatings, paints, and adhesives. Very little, if any, gas-off products were evolved from materials submitted as fabricated sections, e.g., polycarbonates, polyvinylfluorides, and nylon based material.

In general, the major gas-off products were solvents, plasticizers, and monomers. Some coatings desorbed considerable amounts of carbon monoxide. Others gave off relatively large quantities of trimethyl silanol and low molecular weight methyl siloxane polymers.

Although slight differences in relative amounts of alcohols and aldehydes were observed in some gas-off atmospheres, no large changes in atmospheric composition were observed that could be attributed to increased oxidation when materials were exposed at 23-25°C to oxygen at 5 psia.

Quantitative analyses of the gas-off products were influenced by uniformity of sample lots, sample homogeneity, freshness of sample, free surface area, adsorptive characteristics of the encapsulating chamber, method of sampling the gaseous atmosphere, and method of analysis.

Additional analyses were performed on desorbates from four carbon canisters from space cabin simulators and the hydrolysis products of MCS 198.

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SECTION I

INTRODUCTION

A potential problem in manned space programs is the possible contamination of the cabin atmosphere. Considerable data on trace atmospheric contaminants from the atomic submarine programs (Refs. 1-12) and from various space cabin simulators (Refs. 12-18) have shown that sources of contamination may include biological products and the materials of construction. Limited information on the specific gas-off products from individual cabin materials is available (Refs. 19-20).

To establish the possible gas-off and oxidation products from cabin materials, a program using bench-scale environmental simulators was initiated. Fifty candidate materials were tested and over 1000 gaseous environments were analyzed to identify the gas-off products and to estimate the concentration and the gas-off rates of these potential contaminants. All materials were commercial products provided by the Government. Some were partially-fabricated sections from the Gemini program, whereas others required preliminary preparation.

The experiments were designed to simulate normal conditions, 23-25°C and 20-40% relative humidity, in two atmospheres, air at normal atmospheric pressure and oxygen at 5 psia. To obtain a measure of gas-off rate, all candidate materials were stored in 9-liter, borosilicate glass chambers for periods of 30, 60 and 90 days.

Analysis of the atmospheres from the gas-off chambers was performed by three different analytical operations:

1. Gas chromatographic analysis for carbon monoxide and methane after catalytic reduction of the carbon monoxide.

2. Direct gas chromatographic and mass spectrometric analyses of atmospheres from the gas-off chambers.

3. Condensation of gas-off products at -195°C, fractionation of the composite by gas chromatography, and characterization of the fractions by mass spectrometry and infrared spectrophotometry.

In addition to the gas-off experiments, two other analyses were performed:

1. Identification of desorbates from carbon canisters used in space cabin simulators.
2. Characterization of the hydrolysis products and volatiles formed in the reaction of MCS 198 with LiOH and H_2O.

SECTION II

GAS-OFF EXPERIMENTS

A. EXPERIMENTAL METHOD

1. Types of Candidate Materials and Sample Preparation

Table I lists the candidate materials for cabin construction used in these experiments. All materials were commercial products provided by the Government.

The candidate materials were stored at 23-25°C and 20-40% relative humidity in two atmospheres, air at normal atmospheric pressure, and oxygen at 5 psia. Five test periods were used with each atmosphere.

Individual samples of each candidate material were stored for gas-off periods of 30, 60 and 90 days. Since the freshness of the sample could easily influence the type and the amount of gas-off product, the 30 day test chambers were analyzed, purged of their environments and recharged with air or oxygen. After an additional 30 day period, the atmosphere of the chamber was again analyzed, purged, and recharged. Following an additional 30 days of storage, the chamber was analyzed. The five test periods are designated as: (a) 30 Days, (b) 60 Days, (c) 90 Days, (d) 30 + 30 Days, and (e) 30 + 30 + 30 Days. For each test, duplicate chambers were prepared and analyzed.

All candidate materials were stored in 9-liter, borosilicate glass chambers. Special chamber inlet systems were constructed from borosilicate glass and fitted with greaseless Teflon stopcocks and with Teflon sleeves for the ground joint (Figure 1). Two hundred and ten chambers were used on a staggered schedule over a span of 14 months to permit over 1000 analyses to be performed on a 30, 60 and 90 day schedule.

Before use, chambers were: (a) cleaned with either chromic acid cleaning solution or Fisher Detergent RBS-25 Concentrate, (b) rinsed with distilled water (3 times), and (c) dried with the full heat and air flow of a Master Appliance Heat Gun, NG-501LP (minimum temperature rating of 500°F) for 20 minutes. Analyses of the atmospheres in these chambers by mass spectrometry indicated no contamination.

After completion of a test, the candidate material was removed and the chamber was cleaned according to the procedure shown above. In some cases, pretreatment with an organic

Table I

CANDIDATE MATERIALS

I. ADHESIVES

Adhesive, A-4000
Adhesive, No. 271
Resin, Versamid 125
Neoprene, Phenolic EC-847
Adhesive Tape C/R No. 465 (Y 9010)

II. ELASTOMERS

Elastic Webbing, 731-5RDC
Silastic No. 950
Silastic S2007
Silastic 950-4-400
Silastic 9711-2-480

III. ELECTRICAL INSULATION AND WIRING

Wire (MIL-W-16878-C), Type E 22-W-9
5M114E22W9

IV. FINISHES, COATINGS AND MARKING MATERIALS

Velvet Coating No. 104-C 10 Black
Class [illegible] Silicone Impregnating Varnish, No. 997
✓ 620 Light Gull Gray XA-193
3615 Gray XA-194
Red Dye, Red PL
Silver Marking Ink No. 1448 (with cresylic acid)

V. FOAMS

Latex Foam Rubber
Lockfoam C-605 (R and T)
Lockfoam E-302 (R and T)
Lockfoam G-502 (R and T)
Silastic Sponge 445 Base
(3.5/300 + 10/400)

VI. GREASES AND LUBRICANTS

Flurolube Oil Grade FS-5
Fluorolube Grease Grade GR-544, Type LG
Silicone Fluid No. 200
Silicone Fluid F-50
Silicone Grease G-300
Silicone Release Agent DC-7
DC-4 (MIL-I-8660)
Wax Lubricant No. 111

VII. MOLDING MATERIALS

(See Section IX)

VIII. PLASTIC LAMINATES

(None)

IX. POTTING AND SEALING COMPOUNDS

Silastic RTV 882
Silastic RTV 731
Sealant RTV 90
Silastic RTV 501
Silastic C/R Q-3-0121
Silicone EC 1663
Sealer - Epon 828
Silicone Primer A-4004
Silicone Primer SS-4004
Silicone Primer EC-1694
Electrical Resin, Scotchcast No. 8
DC-325

X. THERMOPLASTICS

Polycarbonate, Lexan (1 1/4" cylinder)
Polycarbonate, Lexan (1 1/4" x 2 1/4" x 36")
Polyvinylfluoride
Plexiglas Clear No. 2 (MIL-P-5425)
Plexiglas No. 2 Clearmil
Blue Thermofit RNF 100
Thermofit Tubing Splicer
C/R 197-075
Thermofit Molded Parts Type S
(6005-2915-S) (5M83354)
Nylatron G5 (MILP-46060)
Acetal Resin, Delrin No. 100

XI. MISCELLANEOUS

LA-91, Magnesium/Lithium Alloy
LA-141, Magnesium/Lithium Alloy
LA-2-933, Magnesium/Lithium Alloy

Figure 1. Gas-Off Chamber and Collection Helix.

solvent, e.g., methylene chloride, chloroform or acetone, was required. Whenever the use of the organic solvent was necessary, the full cleaning process was repeated several times to eliminate contamination, as determined by mass spectrometry.

A weighed portion (10-100 grams) of each sample was placed into the 9-liter chamber in a manner to provide the largest possible surface area. Whenever possible, the candidate materials were put into the chambers in the same state as received. Materials such as paints and inks were applied to an aluminum foil substrate and allowed to dry under conditions of temperature and time designated by the manufacturer. Similarly, two-part resins were mixed and cured according to procedures submitted by the manufacturers. All calculations were made on basis of the dry sample weight. Control chambers (containing only aluminum foil) were processed concurrently with those chambers containing the test materials. No contamination was detected from the control chambers.

2. Preparation of Chamber Atmospheres

a. Air at 23-25°C, 1 Atmosphere Pressure and 20-40% Relative Humidity

Chambers were purged with six to ten changes of air-zero gas (less than 2 ppm hydrocarbon) supplied by Matheson Co. Relative humidity was adjusted to 20-40% by bubbling the air-zero gas through triply distilled water cooled externally to 0°C in an ice bath and by allowing the air to reach equilibrium in the chamber at approximately 20-23°C. Measurement of relative humidity was made on the effluent gas from the chamber with an Alnor type 7300 Dew-Pointer. The chambers were stored in the absence of light in large metal cabinets for the 30, 60 and 90 day periods. Agitation of samples was performed every seven days.

b. Oxygen at 23-25°C, 5 psia, and 20-40% Relative Humidity

The relative humidity of oxygen-zero gas (less than 10 ppm hydrocarbon) supplied by Matheson Co. was adjusted to between 20 and 40% by the following procedure. The chamber was purged with six to ten changes of oxygen saturated with water by bubbling the gas through triply distilled water at 23°C. The pressure in the chamber was reduced to 260 mm Hg (5 psia), removing roughly 2/3 of the oxygen and 2/3 of the water. Thus, the relative humidity was approximately 33%. Measurement of relative humidity was made with an Alnor Type 7300 Dew-Pointer.

Because of slight differences in characteristics of the ground joints, some of the chambers would not maintain the reduced pressure of 5 psia. Minor leaks were eliminated by the use of either of two sealants, Apiezon wax or a polyester cement, Atlantic Hard Cement, both routinely used in mass spectrometry and possessing low vapor pressures. These sealants were applied only to the exterior crevices of the joints. Very little, if any, of the sealants was exposed to the chamber atmosphere. In either case, control chambers were processed concurrently. No contamination was detected from the sealants.

3. Analytical Methods

In the first stages of the program, all analyses, except the carbon monoxide determination, were performed on the condensates obtained by passing the total atmosphere from the 9-liter chamber through a trap cooled to -195°C with liquid nitrogen. The pressure in the trap was maintained at less than 0.5 atmosphere to minimize the condensation of oxygen (Ref. 17).

Later development of more efficient mass spectrometric and gas chromatographic techniques[1] resulted in an increase in sensitivity and attendant lower detection levels. Analytical methods were developed which use aliquots of chamber atmosphere and allowed the detection of <0.001 mg of individual contaminant/10 grams of candidate material in a 9-liter volume of chamber atmosphere. Only in the extreme cases, where little if any gas-off products were evolved, was the total 9-liter volume processed.

a. Gas Chromatographic Analysis for Methane and Carbon Monoxide

Carbon monoxide and methane were determined by using a variation of a sensitive and accurate gas chromatographic method developed by Schwenk, et al. (Ref. 21). A 3.3 ml gas sample (measured volume of a commercial 5 ml sample loop) from the test chamber is passed through a Linde 5A molecular sieve to isolate carbon monoxide from the other atmosphere gases, particularly methane. The carbon monoxide is reduced to methane by passage over a nickel catalyst at 360°C in an atmosphere of hydrogen

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(1) Approximately 4-fold increase in sensitivity was obtained by operating the F&M Gas Chromatograph, Model 810, with a single flame ionization detector rather than with the normal dual flame detection system.

carrier gas. Methane originally present and that produced from the reduction of carbon monoxide, are eluted separately and detected by a flame ionization detector. The peaks are compared with a standard concentration of carbon monoxide in nitrogen. The sensitivity is approximately 2 x 10^{-8} grams of carbon monoxide. The analytical system is shown in Figure 2. A cross-check of the higher carbon monoxide levels was made with a Monoxor carbon monoxide detector tube.

b. Gas Chromatographic Analysis of Gas-Off Products

Gas chromatography was used primarily for its high efficiency fractionating capability. Component identification from retention data and quantitative analyses by peak height were used only to support mass spectrometry data.

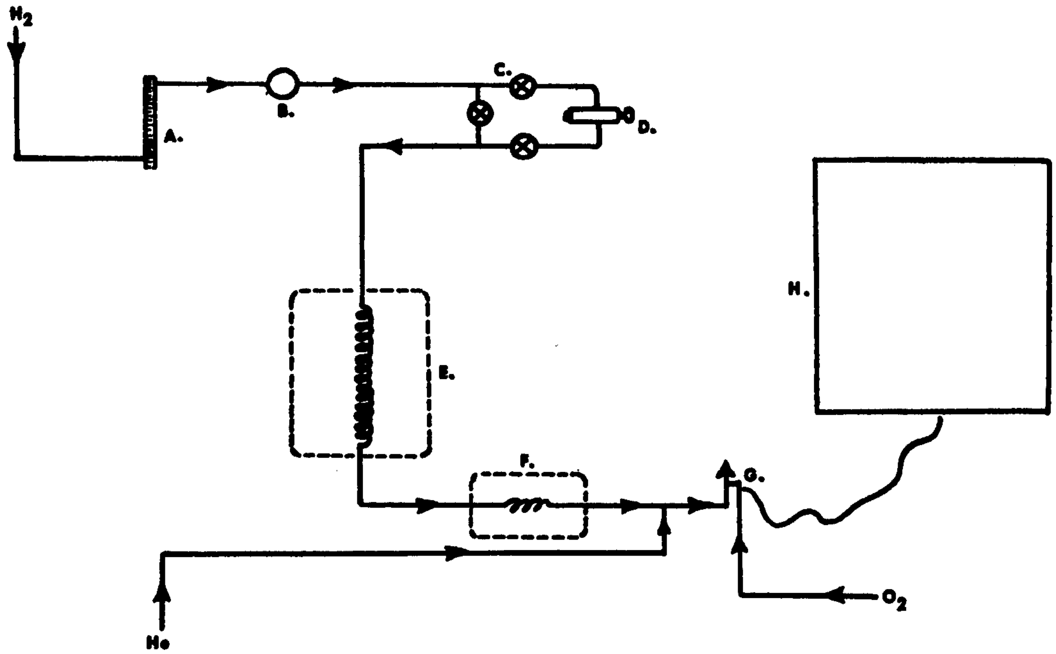
The general analyses of the gas-off products by gas chromatography were performed by introducing 25 ml of the atmosphere from the gas-off chambers directly into the gas chromatograph by the sampling system illustrated in Figure 3. The calibrated sample loop was evacuated and attached directly to the 9-liter chamber by a ground glass joint.

Larger volumes can be sampled, if needed, but 25 ml is the volume of chamber atmosphere which, in general, permits operation of the chromatograph with minimum peak broadening and no significant loss of resolution. Also, the removal of such a small relative volume from the 9-liter chamber permits repeated samplings without upsetting the equilibrium. As determined by sampling at various heights in the chamber, there is no evidence for stratification of gas-off components.

The chamber atmospheres were analyzed on an F and M Model 810 Research Gas Chromatograph equipped with two recording systems and three detectors, dual flame ionization, thermal conductivity and electron capture. Most of the analyses were performed using the flame ionization detection system.

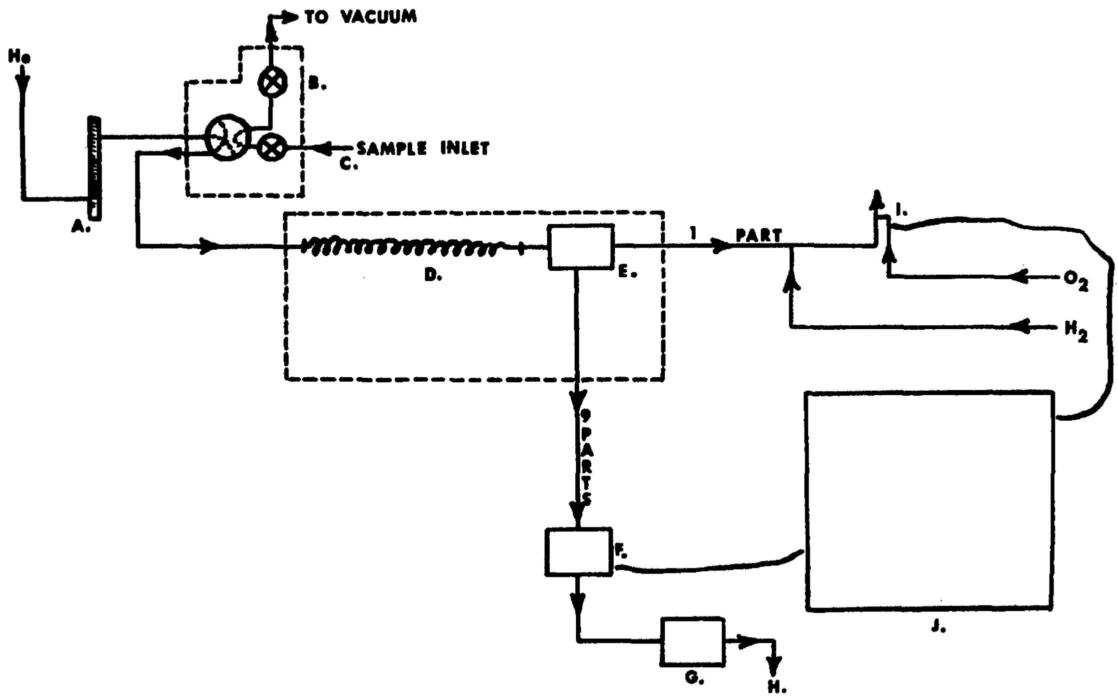
In most cases, a general purpose column, Carbowax 20M on Gas Pack F (temperature programmed 40°-230°C at 10°C/min.), was used because of its excellent partitioning properties for both polar and nonpolar compounds, and its stability at relatively high temperatures. Other columns were employed as needed. Gas chromatography instrument conditions are presented in Table XXCIX, Appendix III.

When needed, quantitative gas chromatography data were obtained by comparing the peak heights with those of a standard mixture. Table II lists typical compounds and their respective detection limits with the flame ionization detector.



A. HYDROGEN FLOWMETER.
B. FLOW REGULATOR.
C. TOGGLE VALVE BY-PASS SYSTEM.
D. BARBER-COLMAN GAS SAMPLING VALVE (DETACHABLE).
E. CHROMATOGRAPHIC COLUMN AND OVEN.
F. CATALYTIC COLUMN AND OVEN.
G. FLAME IONIZATION DETECTOR.
H. AMPLIFICATION AND RECORDING SYSTEM.

Figure 2. Carbon Monoxide and Methane Analyzer.



A. FLOWMETER.
B. PERKIN-ELMER GAS SAMPLING VALVE WITH TOGGLE VALVES [⊗] ON SAMPLE INLET AND VACUUM LINE.
C. GAS-OFF CHAMBER ATTACHES HERE.
D. CHROMATOGRAPHIC COLUMN AND OVEN.
E. SAMPLE SPLITTER [1:10 RATIO].
F. THERMAL CONDUCTIVITY DETECTOR.
G. FRACTION COLLECTOR AND HEATER.
H. FRACTION COLLECTOR ATTACHES HERE.
I. FLAME IONIZATION DETECTOR.
J. AMPLIFICATION AND RECORDING SYSTEM.

Figure 3. F & M Model 810 Gas Chromatograph and Sampling System.

Table II

ABSOLUTE SENSITIVITIES OF GLC INSTRUMENTATION TO TYPICAL COMPOUNDS FOUND IN GAS-OFF EXPERIMENTS

Compounds	Weight, grams
ethanol	1.4×10^{-7}
isopropanol	4.1×10^{-7}
n-propanol	8.5×10^{-7}
iso-butanol	6.3×10^{-8}
benzene	4.3×10^{-8}
toluene	4.2×10^{-8}
xylene	5.0×10^{-8}
m-dichlorobenzene	8.3×10^{-8}
trichloroethylene	2.5×10^{-7}
methyl methacrylate	4.8×10^{-8}

Identifications of gas chromatographic fractions were made by collecting components from the effluent gases and by subsequently characterizing them with mass spectrometry or infrared spectrophotometry. Fractions were isolated by splitting the effluent gases, permitting a small percentage (10%) to pass through the flame ionization detector and directing the rest through the trapping system. Several collection systems were used including the F and M Total Collection System, cold traps of various shapes, and packed and unpacked capillaries. A heated outlet was used to eliminate condensation and contamination in the effluent lines of the chromatograph.

c. Mass Spectrometric Analysis of Gas-Off Products

A Consolidated Electrodynamics Corporation Model 21-103C Mass Spectrometer was used in these analyses. This instrument gives complete resolution of mass 350 with usable peak separation to mass 700 or more. Only a few micromoles of material are needed to obtain a suitable spectrum. A heated inlet, maintained at a temperature of 135°C, was used which permitted the introduction of relatively nonvolatile liquids and solids.

Since considerable amounts of gas-off products were obtained from many of the candidate materials, generally only a portion (125 ml) of the atmosphere of the 9-liter bottle was taken for analysis. In cases where the amounts of gas-off products were low, the products were frozen from the entire nine liters of atmosphere. In either case the contaminants were frozen with liquid nitrogen and the oxygen and nitrogen were removed. Water and CO_2 remained along with the gas-off products. The pressure of the material remaining in the trap of known volume was measured, then the mass spectrum was obtained. If large amounts of gas-off products were obtained, they were weighed.

In some cases, the major gas-off components could be identified directly from the mass spectrum. Often, collection of gas chromatographic fractions was necessary to identify minor components. After a component was definitely established as being present, a quantitative estimate of the level was made by using the pressure of the gas-off products at a known volume to indicate the total amount of off-gassing, and the characteristic mass line intensities to provide the amount of each individual component.

d. Collection of Total Amount of Gas-Off Products from Chambers

In cases where little, if any, gas-off products were detected in the general analysis by using gas chromatography or mass spectrometry, the total gaseous atmosphere in the chamber was

processed through the sample trapping system shown in Figure 4. The condensate obtained at -195°C was analyzed by gas chromatography and mass spectrometry.

To ensure complete removal of all gases, a volume of prepurified nitrogen several times the volume of the chamber was drawn through the system, and metered by means of a flowmeter. Isolation of condensables was accomplished by purging the chamber atmosphere through a helix, similar to that shown in Figure 1, which was cooled with a liquid nitrogen bath. To eliminate condensation of oxygen, purging was performed slowly with the pump of the trapping system maintaining pressure of approximately 0.5 atmosphere or less. Under these conditions, oxygen will not liquefy in the trap (Ref. 17). The pressure in the system can be adjusted by means of the needle valves at either end of the trapping train. The needle valves and interconnecting joints were Teflon or Teflon clad.

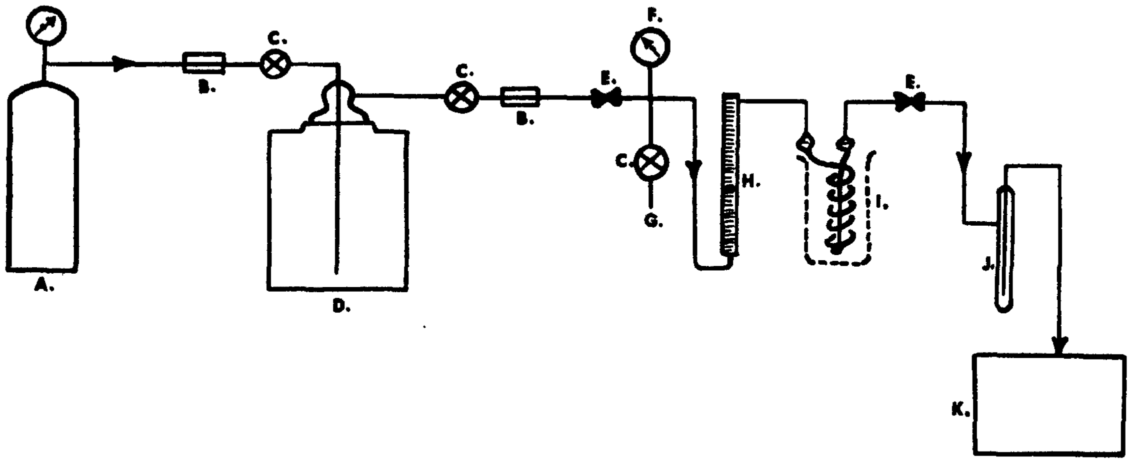
B. RESULTS AND DISCUSSION

1. Sample Preparation

Difficulties were encountered in attempting to obtain sample uniformity. Since most of the candidate materials were submitted for testing in a number of small, individual containers, a problem of mixing existed. Although care was taken to ensure uniformity in mixing and sampling, some inhomogeneities occurred resulting in minor differences in relative amounts of gas-off products.

The problem of inhomogeneity became very apparent when two different batches of Silastic RTV-882 were tested. More than twice the amount of 1-propanol was detected from batch A after 30 days, than from batch B after 60 days.

An additional sampling problem arose when large, one-section samples, e.g., Plexiglas No. 2 Clearmil (approx. 4 sq.ft.), were reduced in size to pass through the opening (1-3/4" diameter) of the gas-off chamber. Despite uniform sample sizes, differences in amounts of fresh surface at the fracture were believed sufficient to cause variations in the quantities of gas-off products.



A. PREPURIFIED NITROGEN.
B. TEFLON SLEEVED GROUND GLASS JOINT.
C. STOPCOCK.
D. GAS-OFF CHAMBER.
E. NEEDLE FLOW CONTROL VALVE.
F. VACUUM GAUGE.
G. VENT.
H. FLOWMETER.
I. HELICAL TRAP IN LIQUID NITROGEN.
J. PUMP ISOLATION TRAP.
K. VACUUM PUMP.

Figure 4. Chamber to Helix Collection System.

2. Analytical Methods

Two methods for sampling the chamber atmospheres were used. As shown in Section II.A.3, these methods were, (a) to isolate all condensables at -195°C from the total 9-liter chamber, and (b) to make aliquots, e.g., 25 ml for gas chromatography and 125 ml for mass spectrometry, from the chamber atmosphere.

Repeatable data were not obtained by condensing at -195°C all the gas-off products from the total 9-liter volume. Up to 5-fold differences in analytical results were observed when comparing data for duplicate chambers. Consequently, this method was only used in special cases, e.g., when gas-off products could not be detected in the aliquots.

Entrainment of volatiles, aerosol formation, and nonquantitative condensation of various types of compounds during the attempted condensation of total gas-off products resulted in loss of some products and considerable variation in relative proportions of the components. Additional losses could be attributed to irreversible adsorption of polar compounds on the glass surfaces, and to polymerization of the silanol gas-off products.

The adsorption effect was considerable when glass beads, sand or glass wool were used as packing to increase the efficiency of the trapping system. The increased surface area and availability of -OH sites permitted greater adsorption. This was particularly true whenever the packings were pretreated with chromic acid solution to remove organic residues, e.g., silicones. This pretreatment produces an increased number of active sites, resulting in greater adsorption of polar compounds from the chamber atmosphere.

Better repeatability of analyses (±100% at the 0.001 mg level and ±25% at the 0.01 mg level between duplicate chambers) was obtained when analyzing aliquots from the chamber atmospheres. Although variations between duplicate chambers were observed, no measurable differences were detected from aliquots taken from the same chamber. The high sensitivities of mass spectrometry and gas chromatography with a flame ionization detector permitted use of relatively small, representative samples of chamber atmosphere with no impairment of the detection levels.

The differences in relative distribution of components obtained by both sampling methods are shown graphically in the gas chromatograms of Silicone Primer SS-4004. Figure 5-A is representative of a 25-ml portion of the gaseous atmosphere, whereas Figure 5-B was obtained from a sample of condensate

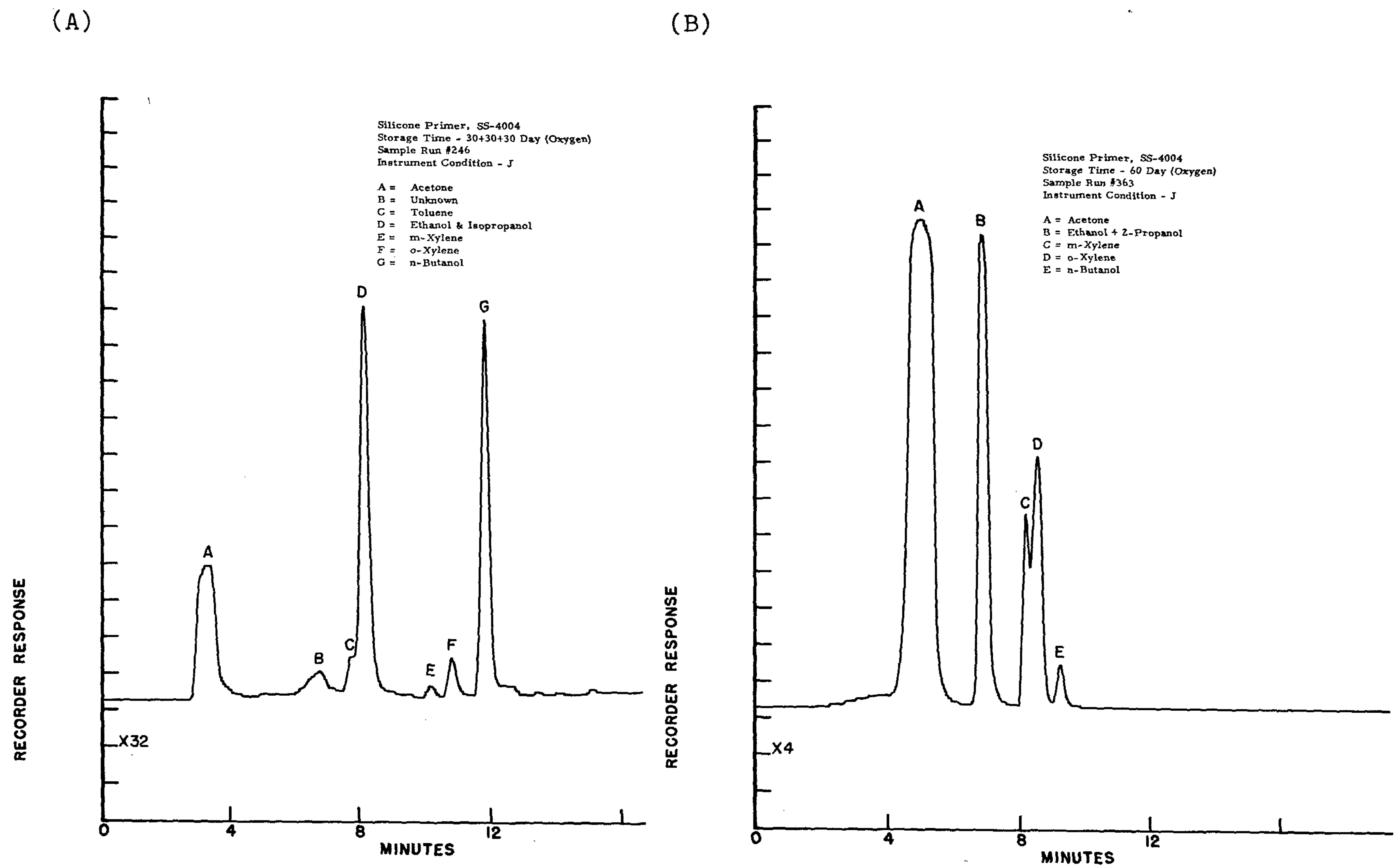


Figure 5. Gas Chromatograms of Gas-Off Products from Silicone Primer SS-4004.

(A) 25 ml aliquot of gaseous atmosphere
(B) Condensables at -196°C from nine liter volume

isolated at -195°C in a helical trap similar to that shown in Figure 1.

3. Analytical Data

Table III lists the types of compounds detected in the chamber atmospheres. These data represent compounds exclusive of the normal constituents of air, i.e., H_2O, CO_2, O_2, N_2, CO, etc. The presence of carbon monoxide was reported only when in excess of 2 ppm of chamber atmosphere, which was the normal content of CO in the "zero" air used in these experiments.

As expected, the major yields of gas-off products occur with the candidate paints and coatings, which desorb entrapped solvents and plasticizers. Small, but still significant, amounts of contaminants result from oxidation, hydrolysis and sublimation processes. Analytical data are presented in Tables VII-XLVI (Appendix I), Tables XLVII-XXCVIII (Appendix II) and Figures 7-43 (Appendix III).

All values appearing in the tables of Appendix I are calculated on the basis of the dried or cured sample. This becomes important in the case of paints and coatings where the weight of the material is substantially reduced by drying.

Representative mass spectral data for the gas-off products from various candidate materials are shown in Tables XLVIII-XXCIX (Appendix II). These data are for the composite of gas-off components from the 9-liter gas-off chambers. An attempt was made to show the contribution of each known component to the total observed mass spectrum. API (American Petroleum Institute) or CEC Keysort Mass Spectra File reference mass spectra of the pure components were used whenever available. The observed spectrum is given in the first column in chart division. Using the relative intensities of the reference spectrum, the contribution in chart divisions for each mass number was calculated for each component. When standard spectra were not available, spectra from our laboratory files were used and are labeled MRC spectra. While care was taken to select API spectra obtained on an instrument similar to the one used for this study, small differences occur between the spectrum of a compound obtained with our instrument and published reference spectra.

In some cases identification of components can be accomplished directly from the mass spectrum for the composite. However, in many cases, isolation and collection of individual components were performed by gas chromatography to obtain additional spectral data on the pure or more concentrated species.

Table III

TYPES OF COMPOUNDS DETECTED

I. Inorganics

Ammonia
Carbon monoxide
Carbonyl sulfide
Carbon disulfide

II. Alkanes

Methane
Variety of C_5-C_7 hydrocarbons, as naphtha

III. Alkenes

Trichloroethylene

IV. Alcohols

Ethanol
2-Ethoxyethanol
n-Propanol
2-Propanol
n-Butanol

V. Alkyl Halides

Trichlorofluoromethane
Variety of low molecular weight, C_6 and lower, chlorofluorocarbons

VI. Carboxylic Acids and Their Derivatives

Acetic acid
2-Ethoxyethylacetate
Methyl methacrylate

VII. Aldehydes

Formaldehyde
Acetaldehyde
Propionaldehyde

Table III - Cont'd

VIII. Ketones

Acetone
Methyl ethyl ketone
Methyl isobutyl ketone

IX. Aliphatic Nitrogen Compounds

Ethylamine

X. Benzene and Its Homologs

Benzene
Toluene
Xylenes
C_3 alkyl benzenes

XI. Aryl Halides

Dichlorobenzene
1,2,4,5-Tetrachlorobenzene

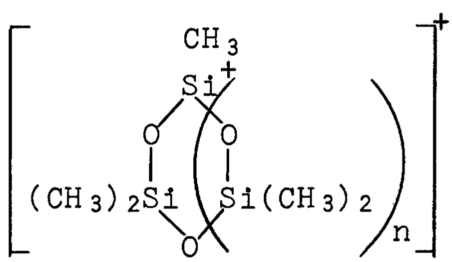
XII. Silicon Compounds

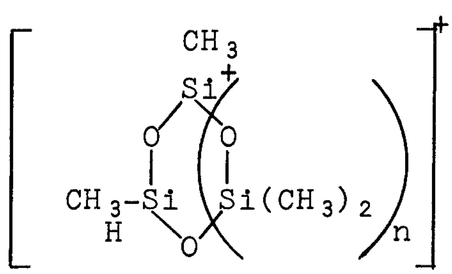
Various cyclic and linear methylsiloxane polymers
Trimethylsilanol

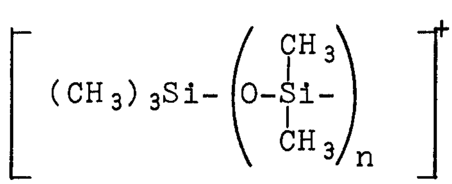
An extreme example of this occurred with Latex Foam Rubber. The mass spectrum of the gas-off products showed only several weak lines, from which no positive identification could be made. However, by subjecting the material to a substantially reduced pressure with slight warming, material was obtained which gave the same lines previously obtained, but now many times stronger. Separation and collection by gas chromatography with subsequent mass spectral characterization provided identification of the components. This scheme was followed whenever identification could not be readily obtained on a direct analysis of the gas-off product mixture.

Hydrocarbons are gas-off components from a number of candidate materials. Where naphtha or petroleum ether are used as solvents, saturated hydrocarbons are obtained in large amounts. These are characterized as to carbon-number range only, with no attempt to specifically identify the multitude of possible isomers present. In these cases, quantitative estimates of the amounts present are obtained from gas chromatography data.

Most of the materials having a silicone base evolved volatile siloxane polymers, both linear and cyclic, having dimethyl siloxy groups as monomer units. These polymers exhibited characteristic mass spectra for the fragments.

(A)  n = 0, 1, 2, 3, 4...

(B)  n = 0, 1, 2, 3, 4...

(C)  n = 0, 1, 2, 3...

The volatile silicone materials are listed in the tables simply as silicone oil. McLafferty (Ref. 22) and Biemann (Ref. 23) list the strong mass spectral lines observed from the volatile components of a silicone grease and suggest species giving rise to them. From their information, most of the siloxane polymeric material observed as gas-off products in these studies arises from a cyclic structure similar to "A". However, in the case of Silicone Fluid, F-50, a linear species similar to "C" was equally important. For this reason a estimate has been made of the amount of silicone oil "A" and silicone oil "C".

Under the conditions of the experiments, 23-25°C and 20-40% R.H., there were no major differences between the types of gas-off products evolved in the tests in air at a pressure of one atmosphere and in oxygen at 5 psia. With some materials, e.g., Class H Silicone Impregnating Varnish, smaller amounts of alcohols were observed in the chambers containing oxygen at 5 psia. In general, the differences between the tests were characterized by some increase in amount of gas-off products in the chambers at reduced pressure.

4. Materials Producing No Gas-Off Products

The candidate materials for which gas-off products were not detected are shown in Table IV. Based on sensitivities for gas chromatography and mass spectrometry, the detection limit is estimated as much less than 0.001 mg/10 grams of candidate material.

Table IV

CANDIDATE MATERIALS YIELDING NO GAS-OFF PRODUCTS

Adhesive Tape C/R No. 465 (Y 9010)
Elastic Webbing, 731-5RDC
Red Dye, Red PL
Silastic Sponge 445 Base (3.5/300 + 10/400)
Polycarbonate, Lexan (1-1/4" cylinder)
Polycarbonate, Lexan (1-1/4" x 2-1/4" x 36")
Polyvinylfluoride
Plexiglas Clear No. 2 (MIL-P-5425)
Blue Thermofit RNF 100
Thermofit Molded Parts Type S
(6005-2915-S) (5M83354)
Nylatron G5 (MIL-P-46060)
Lockfoam G-502 (R & T)

5. Materials Having Unique Gas-Off Characteristics

a. Velvet Coating No. 104-C 10 Black and Class H Silicone Impregnating Varnish No. 997

Most surprising were the high levels of carbon monoxide issuing from several candidate materials. As shown in Tables XVI and XVII, significant amounts of carbon monoxide (0.2 to 5.4 mg/10 grams candidate material) were detected in the chamber atmospheres for Velvet Coating No. 104-C 10 Black, and Class H Silicone Impregnating Varnish No. 997.

Carbon monoxide in the atmosphere above the Velvet Coating arises partly from desorption from carbon which is a major constituent of the coating. Similarly, the presence of methane (0.04-0.16 mg/10 grams candidate material) can be attributed to the retention of small quantities during the formation of the carbon black and subsequent desorption during storage.

Although not evident in the gas-off products of the Velvet Coating No. 104-C Black, condensation of methyl silanols occurred on the inner walls of the chamber to form a methyl siloxy polymer. This oil coating was identified by infrared analysis of the residue.

b. 620 Light Gull Gray XA-193 and 3615 Gray XA-194

There is some mass spectral evidence of the presence of chlorobenzene at very low levels (10^{-3} mg/10 gms) as a gas-off product from the XA-193 and XA-194 Coatings. However, this component has not been conclusively identified.

c. Lockfoams C-605 and G-502

Excessive amounts of carbon dioxide (1-20 mg/10 grams candidate material) were detected in Lockfoams C-605 and G-502. The carbon dioxide is due to gas entrapped during the formation of the polyurethane foams.

d. Fluorolube Oil Grade FS-5 and Fluorolube Grease Grade GR-544, Type LG

The exact structures of the six major components present as gas-off products from Fluorolube Oil Grade FS-5 (Table XXIV, Figure 20) are not presently known, due to lack of reference data. However, the composition of the major mass fragments giving rise to the mass spectrum can be established with reasonable certainty. These fragments are shown in Table V.

Table V

STRONG IONIC SPECIES OBSERVED IN MASS SPECTRUM OF FLUOROLUBE FS-5 GAS-OFF PRODUCTS

Mass	Species		Mass	Species	
66	CClF	*	147	C_3ClF_4	*
68	CClF		149	C_3ClF_4	
69	CF_3		151	$C_2Cl_2F_3$	*
74	C_3F_2		153	$C_2Cl_2F_3$	
85	CF_2Cl	*	163	$C_3Cl_2F_3$	*
87	CF_2Cl		165	$C_3Cl_2F_3$	
93	C_3F_3		185	C_3ClF_6	*
101	CCl_2F	*	187	C_3ClF_6	
103	CCl_2F		201	$C_3Cl_2F_5$	*
105	CCl_2F		203	$C_3Cl_2F_5$	
109	C_3ClF_2		229	$C_4Cl_3F_4$	*
116	C_2ClF_3	*	231	$C_4Cl_3F_4$	
118	C_2ClF_3		247	C_5ClF_8	
131	C_3F_5				
135	C_2ClF_4	*			
137	C_2ClF_4				

*Mass difference due to chlorine 35 and 37 isotopes.

The mass spectrum of any one component, as separated by gas chromatography, does not differ significantly from the mass spectrum of the total mixture. This fact tends to indicate that the components are members of a homologous series probably differing only in chain length. These components have been characterized as chlorine substituted fluorocarbons up to approximately C_6. Infrared absorption, spectrophotometry, nuclear magnetic resonance (^{19}F and ^{1}H) and mass spectral data combine to strongly support this characterization. Similar gas-off products were detected from Fluorolube Grease Grade GR-544, Type LG.

e. Silicone Grease G-300

Several days after the chambers were charged with Silicone Grease G-300 fine needle-like crystals were observed growing on the inner wall of each chamber. This took place with the air atmosphere as well as with the oxygen atmosphere at 5 psi. The crystals were removed and analyzed by mass spectrometry, proving to be tetrachlorobenzene. Subsequent infrared analysis Figure 6, confirmed the material as 1,2,4,5-tetrachlorobenzene.

No tetrachlorobenzene was detected by mass spectrometry analysis of the gas-off products. Apparently, through the sublimation process, the tetrachlorobenzene is deposited in the solid state on the inner surface of the chamber with little, if any, remaining in the gas phase. Although the deposits are considerable, collection and quantitative measurement of this compound directly from the chamber was impossible due to the random scattering of the crystals. Data were obtained from a small scale experiment performed in air at 23°C and 35% relative humidity (Table VI).

f. Plexiglas No. 2 Clearmil

Considerable variance in the amounts of methyl methacrylate evolved from Plexiglas No. 2 Clearmil, Table XLIV, was observed. Although the sample size was kept uniform, differences in amounts of free, freshly exposed surface at the fracture produced varying amounts of methyl methacrylate.

g. Delrin No. 100

The aldehydes reported as gas-off products in Table XLVI for Delrin No. 100 were detected by mass spectrometry, but not by gas chromatography with the flame ionization detector and the Carbowax column.

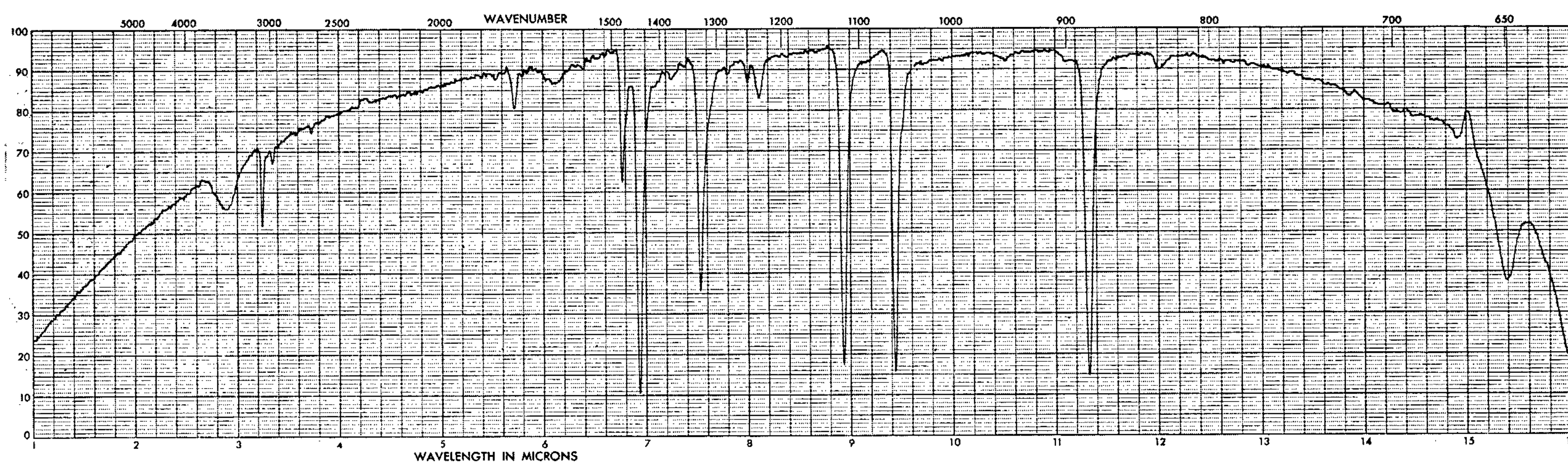


Figure 6. Infrared Spectrum of Sublimate from Silicone Grease, G300 (KBr pellet).

Table VI

SUBLIMATE FROM SILICONE GREASE G-300

Storage Time (Days)	Wt. of 1,2,4,5 Tetrachlorobenzene (mg per 10 g of Silicone Grease)
30	2.1
60	3.3
90	5.8

h. Silastic Sponge 445 Base, Silastic 950-4-400 and Silastic 9711-480

Due to inadequate amounts of sample, only partial testing of Silastic Sponge 445 Base, Silastic 950-4-400 and Silastic 9711-2-480 was performed. Silastic Sponge 445 Base gave no detectable gas-off products. As a cross-check, this candidate material was put directly into the mass spectrometer inlet, under a vacuum of 10^{-5} torr. The only components desorbed were small amounts of water and air.

Small amounts of gas-off products from Silastic 950-4-400 and Silastic 9711-2-480 were detected only by mass spectrometric analysis of the condensables from the total 9-liter chamber volume. The results are reported in Tables XIII and XIV.

i. Resin, Versamid 125

Significant amounts of ammonia and ethyl amine were produced by hydrolysis during the testing of Versamid 125, Table IX. No ammonia or ethyl amine were detected when vapors from fresh polyamide were analyzed.

j. Magnesium/Lithium Alloys LA-91, LA-141, and LA2-933

Magnesium/lithium alloys LA-91, LA-141, and LA2-933 were studied only for a thirty day period. Though no gas-off products were detected by mass spectrometry, several minor components were found by gas chromatography.

The gas-off products were concentrated and isolated by gas chromatography. A mass spectrum of the final collected fraction had lines corresponding to an alcohol. The retention time by gas chromatography did not agree with any of the alcohols up to C_5. Though no positive identification can be made because of the small amount of this material present, it may be a C_5 or higher alcohol. The level is estimated at 0.002 mg or less per 10 grams of candidate material. The component is a gas-off product common to all three alloys.

A second component appears as a gas-off component of LA-91. Its level was estimated at 0.001 mg/10 grams or less. At this low level no identification was possible.

SECTION III

CARBON CANISTERS FROM SPACE CABIN SIMULATORS

A. EXPERIMENTAL METHOD

Desorption of gases from carbon canisters was performed by the technique developed by Saunders (Ref. 16). Materials desorbed at 300°C were collected at -195°C and subsequently fractionated by employing baths at -76°C, 0°C, 23°C and 100°C. Materials vaporized at these temperatures were again collected at -195°C and were analyzed by gas chromatography and mass spectrometry.

F & M Scientific Co. Model 300 and Model 500 Gas Chromatographs with thermal conductivity detectors and a Consolidated Electrodynamics Corporation 21-103C Mass Spectrometer were used in this study. Gas chromatography instrument conditions are shown in Table XC (Appendix IV).

B. RESULTS

Mass spectrometric and gas chromatographic analyses were performed on a series of carbon canisters from space cabin simulators,

1. Carbon Canister 10-12 Day
2. Carbon Canister 16-18 Day
3. Carbon Canister 26-28 Day
4. CBR Carbon 28 Day (Thomas)

Quantitative analytical data are reported in Tables XCI-XCIV for the four carbon canisters and typical gas chromatograms are shown in Figures 44-49 (Appendix IV).

SECTION IV

HYDROLYSIS OF MCS 198 IN PRESENCE OF LiOH

A. EXPERIMENTAL METHOD

1. MCS 198 and Anhydrous LiOH

Weighed amounts (64 grams) LiOH were placed in 1000 ml heavy-walled Erlenemeyer flasks fitted with side-arms. MCS 198 (10 ml) was pipetted uniformly over the surface of the LiOH. The flasks were capped with stoppers having glass inlet tubes extending to approximately 1/2-inch above the surface of the LiOH and the inlet and exit lines were then sealed. Air temperature and relative humidity were 23°C and 35%, respectively. Flasks were stored for 1 hour, 6 hours, and 24 hours. A flask not containing LiOH, but charged with MCS 198 in air, was used as a control. Samples were collected by purging the flasks with prepurified nitrogen and condensing the head gases in a glass helical trap cooled with liquid nitrogen.

2. MCS 198 and Hydrated LiOH

In a system similar to that used in Section II.C.1, 10 ml of MCS 198 was pipetted onto 64 grams of anhydrous LiOH, previously treated with 3 ml of distilled water. Other conditions remained the same.

3. MCS 198 Sprayed Onto Hydrated LiOH

Two ml of MCS 198 was sprayed onto LiOH, previously treated with a stoichiometric amount of water to give $LiOH \cdot H_2O$. The temperature of the reaction chamber, a 1-liter, 4-hole, round bottom flask, was maintained at 150°F. Collections of head gases were made after 5 minutes and 15 minutes.

4. Identification of Hydrolysis Products of MCS 198

To facilitate the identification of the MCS 198 hydrolysis products, two gas chromatographic column systems were used. Octoil S (OS) liquid phase is effective for resolving complex alcoholic mixtures and water, whereas silicon gum rubber (SGR) can be employed in the observation of less volatile materials. Identifications were performed from GLC retention data and mass spectrometric analysis of collected chromatographic fractions.

F and M Scientific Co. Model 300 and Model 500 Gas Chromatographs with thermal conductivity detectors and a Consolidated Electrodynamics Corporation 21-103C Mass Spectrometer were used in this study. The gas chromatography instrument conditions are presented in Table XCV (Appendix V).

B. RESULTS AND DISCUSSION

Results of the MCS 198 + LiOH experiments are reported in Table XCIII and Figures 50-57, Appendix V. The principal components of the head gases exclusive of air, are isopropanol, 2-butanol, water and lesser amounts of the mixed isopropyl and 2-butyl silicates. In addition, trace amounts of ethyl alcohol, o-xylene and secondary alcohols, believed to be mostly C_5, C_6 and C_7 materials, were identified.

The principal components were observed as distinct peaks in the gas chromatograms. o-Xylene and the secondary alcohols with a carbon number greater than C_4 were detected as a relatively weak, broad band extending from 12 to 24 minutes (SGR). Characterization of this peak system was performed by mass spectrometric analysis of a collected GLC fraction and subsequent investigation of retention times of known alcohols and o-xylene.

In addition to o-xylene, it is likely that a much smaller quantity of the other xylene isomers are present also.

As noted from a comparison of the data in Table XCIII for the 24-hour blank and the 24-hour anhydrous LiOH experiment, hydrolysis of MCS 198 is markedly enhanced by the presence of LiOH. Also, most of the hydrolysis, under the static conditions of storage at 23°C and 35% R.H. without agitation, occurs after 6 hours. Diffusion of water from the head gases to the MCS 198-LiOH interface appears to be rate controlling step.

No evidence for any significant hydrolysis was observed in the experiment in which MCS 198 was sprayed onto $LiOH \cdot H_2O$. As shown in Table XCIII, the head gases are primarily water and the mixed isopropyl and 2-butyl silicates. No differences were noted between the two samplings. Contact time was too short to promote any significant hydrolysis. Similar observations were made in the static tests, which showed the greater degree of hydrolysis after 6 hours.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

This study has shown that many factors influence analyses of gas-off products from the candidate materials. The major factors are: (a) physical state and composition of each specimen, (b) adsorptive characteristics of the gas-off chamber, (c) storage time, (d) nature of the chamber atmosphere, (e) method of sampling the chamber atmosphere, and (f) method of analysis. Slight differences in each of these can appear as large relative differences when comparing analytical data for extremely small amounts of gas-off products.

A large part of the variation in yields from the 12 specimens of each candidate material used in these tests can be attributed to differences in physical properties and to changes in chemical composition of the specimens. Some factors affecting the physical properties and the chemical composition are: nonuniformity of sample specimens, possible changes in proprietary mixes between sample lots, localized entrapment of solvent and plasticizers, freshness of sample, variations in sample size and shape, and amount of exposed surface.

The adsorptive characteristics of the inner wall of the glass chamber have a marked influence on the nature and the amounts of gas-off products. Low molecular weight methyl siloxanes were detected as coatings on the glass walls in the tests with silicone-based materials. Not only are the gas-phase analyses for trimethylsilanol and low molecular weight silicones affected, but the coating on the glass surface provides an excellent medium for the potential adsorption of organic compounds from the chamber atmosphere. In addition, the adsorption sites on the glass surface can remove significant amounts of polar gas-off products, e.g., alcohols, acids, ketones and aldehydes, from the gas phase.

The variability in the analytical data produced by sample inhomogeneity and by the adsorptive nature of the glass chamber are sufficient to mask the detection of significant changes in amounts of gas-off products after continuous 30, 60 and 90 day periods. Data for most periods indicate that little increase in gas-off products occurs after the first 30 days.

Generally, the tests, in which the chamber atmospheres were analyzed, purged, and recharged every 30 days for a cumulative time of 90 days, show a reduction in gas-off products after each purging. These data also show some tests in which

the amounts of gas-off products from the second 30 day period are equivalent to the first and are almost equal to the total amount of gas-off products from the continuous 90 day tests. The mechanism by which this desorption occurs is not known, but data indicate a relatively constant amount of gas-off products is in the gas phase during continuous 30, 60 and 90 day storage periods, whereas, repeated evolution of gas-off products occurs if the atmosphere above the candidate material is changed. The amounts of gas-off products accumulated during three purging and recharging tests may be two to three times the quantities measured for a continuous 90 day storage.

The variations in the gas-off products produced in air at a pressure of 1 atmosphere and in oxygen at 5 psia under the conditions of 23-25°C and 20-40% R.H. are believed to result mostly from differences in total pressure, i.e., some increase in gas-off products was obtained at the reduced pressure. Although slight changes in relative amounts of alcohols and aldehydes were detected in some cases, there is not sufficient evidence of a general increase in oxidation in the oxygen atmosphere at 5 psia. There is some evidence for hydrolysis products in both environments.

The methods for sampling the chamber atmosphere can strongly influence the relative amounts of gas-off components isolated for analysis. Problems associated with aerosol formation, entrainment of vapor, adsorption, and possibly hydrolysis or oxidation during isolation and concentration of all the gas-products in each 9-liter chamber by condensation at -195°C, prevented application of this technique in the general quantitative analytical method. A technique, in which an aliquot of the gaseous atmosphere is used for analysis, was found to be more repeatable.

A program, which surveys a wide variety of materials, requires several rapid analytical techniques. Generally, one will not suffice. In this study, there were several cases in which gas-off components were detected by mass spectrometry, but not by gas chromatography. Some of these components were carbon disulfide, carbonyl sulfide, acetic acid, and various aldehydes. Additional analyses for carbon monoxide, methane, and naphtha were more easily obtained by gas chromatography, than by mass spectrometry. For a complete characterization of all components, several techniques, e.g., gas chromatography, mass spectrometry, infrared spectrophotometry, and a variety of classical chemical tests, should be used.

The analytical procedures employed in this program were developed to cover a wide range of candidate materials. For each material, more optimum conditions, particularly in the gas

chromatography operation, could be established. To attain the maximum sensitivity for a particular component, specific column packings, instrument conditions, and detection systems are needed for each type of candidate material.

We have concluded that:

(1) Qualitative identification of gas-off components is possible to the level of 0.1 ppm in the gaseous atmosphere.

(2) Estimates of the amounts of gas-off components can be made from mass spectrometry and gas chromatography analyses, but, at these extremely low levels, considerable variation in the measurements can arise from sample inhomogeneity, occlusion of solvents and plasticizers, slight difference in composition of sample lots, and adsorption phenomena.

Future evaluations of candidate materials should consider the following recommendations:

(1) Whenever possible, materials should be evaluated in their final form and under the conditions of use.

(2) Pretreatment of candidate materials should simulate conditions encountered in use.

(3) To provide quantitative data for meaningful comparison between testing laboratories, some standardizations of sample preparation, i.e., size, shape, exposed surface, etc., should be made. However, the testing laboratories must recognize that the level of gas-off products is generally so small that variations in proprietary mixes, sample homogeneity, occlusion of solvents, and adsorption in the gas-off chamber may influence the yields of gas-off products to a greater degree than small differences in size and shape.

APPENDIX I

ANALYTICAL RESULTS

FOR

GAS-OFF EXPERIMENTS

The following tables list compounds found as gas-off products under the various test conditions. The tests may be summarized as follows:

1. A 30-day gas-off period in (a) air and (b) in 5 psia oxygen.

2. Removal of complete atmosphere from the 30 day test and analysis after a second 30 day period in (a) air and (b) oxygen in 5 psi. Test is designated by "30 + 30 day."

3. Removal of complete atmosphere from above "30 + 30 day" test and analysis after one more 30 day period in (a) air, and (b) oxygen at 5 psia. Test is designated "30 + 30 +30 day."

4. A 60 day undisturbed period in (a) air and (b) oxygen at 5 psia.

5. A 90 day undisturbed period in (a) air and (b) oxygen at 5 psia.

The values for the gas-off product levels are given in milligrams per 10 grams of the cured candidate material. In most cases more than 10 grams of material were used, but each yield of gas-off products was normalized to that of a 10 gram sample. The values reported are averages of two separate experiments.

The order of the tables in this appendix is the same as the order of the candidate materials listed in Table I.

Table VII

GAS-OFF PRODUCTS - ADHESIVE, A-4000

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) n-Propanol & 2-Propanol	Xylene	Trimethyl Silanol	Silicone Oil*	Acetone	Toluene	C_4-C_5 Hydrocarbon
30	Air	1.9	0.3	0.3	0.7	<0.005	0.05	0.6
60	"	1.5	0.3	0.2	0.6	<0.005	0.03	0.6
90	"	1.4	0.3	0.2	0.7	<0.005	0.05	0.7
30 + 30	"	0.7	0.4	0.2	0.6	<0.005	<0.02	0.1
30 + 30 + 30	"	1.5	0.3	0.7	0.5	<0.005	<0.02	0.2
30	Oxygen	0.7	0.5	0.8	0.3	<0.005	0.05	0.5
60	"	0.8	0.1	0.1	0.5	<0.005	0.05	0.5
90	"	1.0	0.06	0.1	0.5	<0.005	0.11	0.6
30 + 30	"	0.7	0.1	0.1	0.5	<0.005	0.04	0.05
30 + 30 + 30	"	0.6	0.2	0.1	0.5	<0.005	0.05	0.03

*See Analytical Data, Results and Discussion, Section II.

Table VIII

GAS-OFF PRODUCTS - ADHESIVE, NO. 271

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)					
		Hydro-Carbons*	Silicone Oil**	Trimethyl Silanol	Xylene	2-Propanol	Ethanol
30	Air	0.2	0.1	0.4	0.002	0.04	0.03
60	"	0.06	0.08	0.7	0.004	0.1	0.1
90	"	0.06	0.1	0.9	0.001	0.3	0.3
30 + 30	"	0.06	0.06	0.3	0.002	0.06	0.05
30 + 30 + 30	"	0.05	0.04	0.5	0.003	0.08	0.09
30	Oxygen	0.3	0.1	0.6	0.01	0.09	0.1
60	"	0.1	0.08	0.9	0.04	0.06	0.05
90	"	0.1	0.2	1.0	0.006	0.1	0.1
30 + 30	"	0.06	0.1	0.8	0.002	0.07	0.07
30 + 30 + 30	"	0.04	0.1	0.7	0.003	0.08	0.07

*Estimated C_4- C_5 from mass spectral data.

**See Analytical Data, Results and Discussion, Section II.

Table IX

GAS-OFF PRODUCTS - RESIN, VERSAMID 125

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Ammonia	Ethyl Amine	Xylene	CO
30	Air	0.7	0.005	0.0004	*
60		1.2	0.006	0.0007	*
90		2.6	0.01	0.001	0.077
30 + 30		2.0	0.004	N.D.	0.072
30 + 30 + 30		2.6	0.02	N.D.	0.021
30		1.5	0.006	0.004	*
60		3.0	0.02	0.003	0.028
90		4.1	0.01	0.008	0.062
30 + 30		1.7	0.02	N.D.	0.025
30 + 30 + 30		4.1	0.03	N.D.	0.020

*Not determined.

Additionally, n-propanol was detected by gas chromatographic analysis of the condensables from the total nine liter volume. Level is estimated at less than 0.001 mg/10 g.

See Part 5.i, Results and Discussion, Section II.

Table X

GAS-OFF PRODUCTS - NEOPRENE, PHENOLIC EC-847

Storage Time (Days)	Atmosphere	C6 - C7* Hydrocarbons	Weight of Component (mg per 10 g Candidate Material)					
			Acetone	Methyl Ethyl Ketone	Benzene	n-Propanol	Toluene	Xylene
30	Air	13.5	14.2	1.8	0.6	7.6	4.8	0.3
60	"	13.8	15.1	3.4	1.2	7.1	5.9	0.6
90	"	10.7	12.3	4.2	0.8	7.7	7.2	1.1
30 + 30	"	5.4	9.9	2.2	0.7	5.2	3.7	0.3
30 + 30 + 30	"	2.5	11.3	1.5	0.4	4.1	3.6	0.3
30	Oxygen	12.0	12.8	3.7	0.7	7.5	8.8	1.3
60	"	13.9	11.3	3.2	1.0	7.0	5.5	0.6
90	"	14.1	14.6	4.4	0.9	8.7	8.1	1.4
30 + 30	"	5.2	15.5	1.7	0.6	6.3	5.8	1.2
30 + 30 + 30	"	2.7	12.9	1.8	0.4	5.8	6.7	1.1

* 2-methyl pentane, 3-methyl pentane 2,3 dimethyl pentane, 2,4 dimethyl pentane, hexane were identified specifically though others may be present.

Table XI

GAS-OFF PRODUCTS - SILASTIC NO. 950

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Sat.* Hydrocarbon
30	Air	0.005
60	"	0.005
90	"	0.002
30 + 30	"	0.007
30 + 30 + 30	"	0.002
30	Oxygen	0.002
60	"	0.003
90	"	0.003
30 + 30	"	0.002
30 + 30 + 30	"	0.002

*Approximately C_5 according to mass spectra data.

Table XII

GAS-OFF PRODUCTS - SILASTIC S2007

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Ethanol	Acetaldehyde	Silicone Oil*	Dichlorobenzene	CO
30	Air	2.1	0.21	0.55	<0.005	**
60	"	1.9	0.44	0.50	<0.005	0.013
90	"	1.1	0.66	0.47	<0.005	**
30 + 30	"	1.8	0.85	0.73	<0.005	0.008
30 + 30 + 30	"	0.2	0.22	0.11	N.D.	0.006
30	Oxygen	1.1	0.30	0.50	<0.005	**
60	"	1.9	0.53	0.32	<0.005	0.007
90	"	0.8	0.80	0.27	N.D.	0.027
30 + 30	"	1.7	1.5	0.20	N.D.	0.005
30 + 30 + 30	"	1.0	2.8	0.20	N.D.	0.005

*See Analytical Data, Results and Discussion, Section II.

**Not determined.

Note: Additionally, n-Butanol appears in the 90 day experiments at a level of less than 0.1 mg/10 grams.

Table XIII

GAS-OFF PRODUCTS - SILASTIC 950-4-400

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)	
		Ethanol	Silicone Oil**
30	Air	.05	.023
60	"	*	*
90	"	*	*
30 + 30	"	.008	.012
30 + 30 + 30	"	.003	--
30	Oxygen	*	*
60	"	*	*
90	"	*	*
30 + 30	"	*	*
30 + 30 + 30	"	*	*

*No other experiments were performed on this candidate material since only a small supply was available.

**See Analytical Data, Results and Discussion, Section II.

Table XIV

GAS-OFF PRODUCTS - SILASTIC 9711-2-480

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Silicone Oil**
30	Air	<0.01
60	"	*
90	"	*
30 + 30	"	<0.01
30 + 30 + 30	"	<0.01
30	Oxygen	*
60	"	*
90	"	*
30 + 30	"	*
30 + 30 + 30	"	*

*No other experiments were performed on this candidate material since only a small supply was available.

**See Analytical Data, Results and Discussion, Section II.

Table XV

GAS-OFF PRODUCTS WIRE (MIL-W-16878-C) TYPE E 23-W-9

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material) Sat. Hydrocarbon*
30	Air	<0.005
60	"	<0.005
90	"	<0.005
30 + 30	"	<0.005
30 + 30 + 30	"	<0.005
30	Oxygen	<0.005
60	"	<0.005
90	"	<0.005
30 + 30	"	<0.005
30 + 30 + 30	"	<0.005

* C_6 or lower by Mass Spectrometry.

Table XVI

GAS-OFF PRODUCTS - VELVET COATING NO. 104-C 10 BLACK

Storage Time (Days)	Atmosphere	Wt. of Component (Mg per 10 g Candidate Material)						
		Ethanol	Acetone	Methylethyl Ketone	Toluene	CO	Methane	Naphtha*
30	Air	0.3	0.1	0.4	0.02	2.8	0.04	1.0
60	"	0.3	0.3	0.5	0.02	3.6	0.06	1.0
90	"	0.1	0.1	0.4	0.02	4.5	0.10	1.0
30 + 30	"	0.05	0.1	0.3	0.02	0.7	N.D.	0.4
30 + 30 + 30	"	0.04	0.08	0.2	0.01	0.6	N.D.	0.4
30	Oxygen	0.4	0.5	0.3	0.2	4.9	0.16	1.0
60	"	0.2	0.1	0.6	0.02	4.0	0.08	1.0
90	"	0.08	0.3	0.5	0.01	5.4	0.12	1.0
30 + 30	"	0.09	0.09	0.3	0.02	1.2	N.D.	0.5
30 + 30 + 30	"	0.07	0.09	0.3	0.01	0.9	N.D.	0.4

*Estimated from group of GLC peaks characteristic of C_5-C_7 hydrocarbons.

See Part 5.a, Results and Discussion, Section II.

Table XVII

GAS-OFF PRODUCTS - CLASS H SILICONE IMPREGNATING VARNISH NO. 997

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Ethanol	Propionaldehyde	Benzene	Toluene	Xylene	CO
30	Air	0.2	0.7	0.1	0.05	0.2	2.3
60	"	0.3	0.5	0.02	0.004	0.01	2.4
90	"	0.2	0.4	0.04	0.05	0.01	2.7
30 + 30	"	0.4	0.2	0.01	0.03	0.1	0.3
30 + 30 + 30	"	0.4	0.1	N.D.	N.D.	N.D.	0.2
30	Oxygen	0.04	0.5	0.02	0.2	0.3	2.0
60	"	0.05	0.2	0.02	0.5	0.2	2.6
90	"	0.05	0.4	0.02	0.9	0.7	2.9
30 + 30	"	0.03	0.1	0.02	0.6	1.0	0.7
30 + 30 + 30	"	0.04	0.2	0.04	0.7	2.0	0.5

Table XVIII

GAS-OFF PRODUCTS - 620 LIGHT GULL GRAY COATING, XA-193

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)						
		Ethanol	2-Propanol	C_6-C_{10} Sat. Hydrocarbon(s)	Methyl Ethyl Ketone	Benzene	Toluene	Xylene
30	Air	0.7	2.5	0.3	2.5	0.6	2.6	2.0
60	"	0.6	3.0	0.5	1.8	1.2	0.3	2.3
90	"	0.5	3.0	0.5	1.1	0.5	5.0	3.9
30 + 30	"	0.5	3.5	0.5	0.9	0.6	5.9	4.1
30 + 30 + 30	"	0.02	0.06	0.07	0.2	0.2	2.4	2.4
30	Oxygen	0.2	2.4	1.5	0.4	0.1	4.7	2.5
60	"	0.1	1.2	0.2	0.8	0.3	5.9	4.0
90	"	0.1	1.5	1.0	2.0	1.2	13	23
30 + 30	"	0.3	3.0	0.5	1.3	0.7	10	8.2
30 + 30 + 30	"	0.08	1.1	0.2	1.8	0.5	13	16

See Part 5.b, Results and Discussion, Section II.

Table XIX

GAS-OFF PRODUCTS - 3614 GRAY COATING, XA-194

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Ethanol	2-Propanol	Methyl Ethyl Ketone	Toluene	Xylene	Sat. Hydrocarbons
30	Air	1.5	1.1	0.4	7.1	2.9	0.3
60	"	1.4	0.7	0.7	13.5	13.4	1.1
90	"	1.0	0.3	0.3	7.6	13.8	0.4
30 + 30	"	1.1	0.8	0.5	12.1	5.8	0.5
30 + 30 + 30	"	0.6	0.5	0.3	8.1	4.2	0.2
30	Oxygen	3.7	3.0	0.9	12.2	5.7	0.6
60	"	0.8	0.9	0.3	6.3	5.7	0.4
90	"	0.6	0.7	N.D.	3.3	4.8	0.4
30 + 30	"	0.7	0.4	0.1	2.9	2.0	0.1
30 + 30 + 30	"	0.5	0.3	0.2	2.1	1.5	0.1

See Part 5.b, Results and Discussion, Section II.

Table XX

GAS-OFF PRODUCTS - SILVER MARKING INK NO. 1448 (W/Cresylic Acid)

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)			
		2-Ethoxy-Ethanol	2-Ethoxy Ethyl Acetate	Acetone	CO
30	Air	0.3	7.0	0.1	0.08
60	"	0.9	6.8	0.2	0.2
90	"	0.6	12.5	0.7	0.2
30 + 30	"	0.4	15.0	0.4	0.06
30 + 30 + 30	"	0.5	11.8	0.3	0.09
30	Oxygen	0.7	10.8	0.2	0.1
60	"	0.5	9.5	0.2	0.1
90	"	0.3	9.2	0.2	0.1
30 + 30	"	0.1	9.0	0.1	0.08
30 + 30 + 30	"	0.2	7.1	0.1	0.09

Table XXI

GAS-OFF PRODUCTS - LATEX FOAM RUBBER

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Carbonyl Sulfide	Carbon Disulfide
30	Air	0.03	0.002
60	"	0.05	0.002
90	"	0.09	0.004
30 + 30	"	0.03	0.001
30 + 30 + 30	"	0.04	0.001
30	Oxygen	0.07	0.002
60	"	0.10	0.002
90	"	0.12	0.004
30 + 30	"	0.12	0.002
30 + 30 + 30	"	0.13	0.002

See Analytical Data, Results and Discussion, Section II.

Table XXII

GAS-OFF PRODUCTS - LOCKFOAM C-605 (R&T)

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) CO
30	Air	<0.001
60	"	<0.001
90	"	<0.001
30 + 30	"	<0.001
30 + 30 + 30	"	<0.001
30	Oxygen	<0.001
60	"	<0.001
90	"	0.08
30 + 30	"	<0.001
30 + 30 + 30	"	<0.001

See Part 5.c, Results and Discussion, Section II.

Table XXIII

GAS-OFF PRODUCTS - LOCKFOAM E-302 (R&T)

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) (Freon-11) Trichlorofluoro Methane
30	Air	43
60	"	75
90	"	42
30 + 30	"	13
30 + 30 + 30	"	7.5
30	Oxygen	27
60	"	20
90	"	45
30 + 30	"	20
30 + 30 + 30	"	8.3

Table XXIV

GAS-OFF PRODUCTS - FLUOROLUBE OIL - GRADE FS-5

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)					
		A	B	C	D	E	F
30	Air	0.11	0.04	0.05	0.05	-	-
60	"	0.16	0.07	0.09	0.03	0.09	0.01
90	"	0.11	0.04	0.06	0.02	0.05	0.005
30 + 30	"	0.09	0.03	0.05	0.02	0.04	0.005
30 + 30 + 30	"	0.10	0.04	0.06	0.03	0.05	0.004
30	Oxygen	0.14	0.11	0.10	0.09	-	-
60	"	0.16	0.07	0.09	0.03	0.08	0.01
90	"	0.11	0.04	0.06	0.02	0.05	0.005
30 + 30	"	0.11	0.04	0.06	0.03	0.05	0.01
30 + 30 + 30	"	0.10	0.04	0.06	0.03	0.05	0.004

Components A through F are various chlorofluorocarbons, C_6 or lower.

See Table XLV, and Results and Discussion, Section II.

Table XXV

GAS-OFF PRODUCTS - FLUOROLUBE GREASE - GRADE GR-544 TYPE LG

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)			
		n-Butanol	Total CClF Components	Benzene	Toluene
30	Air	0.2	0.02	0.006	<0.001
60	"	0.2	0.02	0.001	<0.001
90	"	0.2	0.02	0.001	<0.001
30 + 30	"	0.1	0.01	<0.001	<0.001
30 + 30 + 30	"	0.2	0.005	<0.001	<0.001
30	Oxygen	0.3	0.02	0.002	<0.001
60	"	0.2	0.02	0.002	N.D.
90	"	0.3	0.03	0.003	0.003
30 + 30	"	0.3	0.02	0.001	<0.001
30 + 30 + 30	"	0.2	0.01	<0.001	<0.001

See Results and Discussion, Section II.

Table XXVI

GAS-OFF PRODUCTS - SILICONE FLUID NO. 200

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)				
		Ethanol	Toluene	Xylene	Silicone Oil*	Trimethyl Silanol
30	Air	0.003	0.003	N.D.	0.008	0.003
60	"	<0.001	0.003	N.D.	0.015	0.002
90	"	N.D.	0.002	N.D.	0.007	0.002
30 + 30	"	0.006	0.03	0.04	0.04	0.006
30 + 30 + 30	"	0.005	0.01	0.01	0.03	0.003
30	Oxygen	0.002	0.002	<0.001	0.003	0.005
60	"	<0.001	<0.001	<0.001	0.006	<0.001
90	"	<0.001	0.006	N.D.	0.005	<0.001
30 + 30	"	N.D.	0.015	0.008	0.01	0.003
30 + 30 + 30	"	0.003	0.004	0.005	0.005	<0.001

*See Analytical Data, Results and Discussion, Section II.

Table XXVII

GAS-OFF PRODUCTS - SILICONE FLUID F-50

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)					
		Ethanol	Trimethyl Silanol	Toluene	Xylene	Silicone Oil (a)*	Silicone Oil (C)*
30	Air	0.006	0.05	<0.001	N.D.	0.01	0.01
60	"	0.007	0.04	N.D.	N.D.	0.004	0.008
90	"	0.002	0.02	0.002	N.D.	0.003	0.03
30 + 30	"	0.004	0.06	0.005	N.D.	0.03	0.06
30 + 30 + 30	"	<0.001	0.003	N.D.	N.D.	0.008	0.008
30	Oxygen	0.003	0.11	0.003	0.002	0.03	0.5
60	"	0.005	0.02	<0.001	N.D.	0.005	0.2
90	"	0.003	0.01	N.D.	N.D.	0.02	0.3
30 + 30	"	0.002	0.02	<0.001	N.D.	0.005	0.2
30 + 30 + 30	"	0.002	0.01	<0.001	<0.001	<0.001	0.03

*See Analytical Data, Results and Discussion, Section II.

Table XXVIII

GAS-OFF PRODUCTS - SILICONE GREASE G-300

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)			
		Alcohols*	Trimethyl Silanol	Trichloroethylene	Silicone Oil**
30	Air	0.04	0.28	0.43	0.29
60	"	0.02	0.04	0.02	0.01
90	"	0.03	0.35	0.04	0.006
30 + 30	"	0.003	0.05	0.02	0.04
30 + 30 + 30	"	0.007	0.01	0.02	0.05
30	Oxygen	0.01	0.45	0.27	0.15
60	"	0.006	0.35	0.06	0.007
90	"	0.007	0.37	0.1	N.D.
30 + 30	"	0.02	0.23	0.17	0.02
30 + 30 + 30	"	<0.001	<0.001	N.D.	<0.001

*Combined ethanol and n-propanol.

**See Part 5.e and Analytical Data, Results and Discussion, Section II.

Table XXIX

GAS-OFF PRODUCTS - SILICONE RELEASE AGENT DC-7

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material) Acetaldehyde	Ethanol	Silicone Oil*
30	Air	N.D.	0.05	0.04
60	"	0.1	0.09	0.08
90	"	0.004	0.07	0.04
30 + 30	"	0.05	0.08	0.08
30 + 30 + 30	"	0.01	0.02	0.02
30	Oxygen	N.D	0.2	0.03
60	"	0.008	0.1	0.06
90	"	0.009	0.07	0.05
30 + 30	"	0.02	0.07	0.07
30 + 30 + 30	"	0.01	0.03	0.02

*See Analytical Data, Results and Discussion, Section II.

Table XXX

GAS-OFF PRODUCTS - DC-4 (MIL-I-8660)

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)			
		Ethanol	Silicone Oil*	Trimethyl Silanol	Saturated** Hydrocarbon
30	Air	0.05	0.08	0.003	N.D.
60	"	0.06	0.07	0.005	0.009
90	"	0.06	0.1	0.004	0.02
30 + 30	"	0.03	0.06	0.002	0.01
30 + 30 + 30	"	0.03	0.05	0.002	0.002
30	Oxygen	0.08	0.05	0.004	N.D.
60	"	0.1	0.06	0.004	0.004
90	"	0.1	0.08	0.004	0.02
30 + 30	"	0.06	0.09	0.004	0.009
30 + 30 + 30	"	0.05	0.08	0.004	0.02

*See Analytical Data, Results and Discussion, Section II.

** C_4-C_5 Hydrocarbon according to mass spectral data.

Table XXXI

GAS-OFF PRODUCTS - WAX LUBRICANT NO. 111

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)
		Petroleum Ether
30	Air	0.9
60	"	2.2
90	"	4.2
30 + 30	"	0.4
30 + 30 + 30	"	0.2
30	Oxygen	6.9
60	"	7.8
90	"	5.0
30 + 30	"	3.6
30 + 30 + 30	"	2.0

Table XXXII

GAS-OFF PRODUCTS - SILASTIC RTV-882

Storage Time (Days)	Wt. of Component (mg per 10 g Candidate Material)			
	Atmosphere	1-Propanol	Toluene	Silicone Oil
30	Air	2.1*	0.02	0.03
60	"	0.5	0.03	0.02
90	"	0.9	0.02	0.5
30 + 30	"	1.2	0.009	0.3
30 + 30 + 30	"	0.8	N.D.	0.08
30	Oxygen	2.6*	0.04	0.2
60	"	1.1	N.D.	0.04
90	"	3.6	0.02	0.06
30 + 30	"	2.5	<0.008	0.02
30 + 30 + 30	"	2.0	N.D.	0.05

* Samples prepared from a separate batch of RTV882.

See Sample Preparation, Results and Discussion, Section II.

Table XXXIII

GAS-OFF PRODUCTS—SILASTIC RTV-731

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Acetic Acid	Trimethyl Silanol
30	Air	1.4	0.003
60	"	0.1	0.010
90	"	0.008	N.D.
30 + 30	"	1.3	0.003
30 + 30 + 30	"	0.7	0.002
30	Oxygen	0.8	0.005
60	"	0.2	0.02
90	"	0.7	0.03
30 + 30	"	0.4	0.008
30 + 30 + 30	"	0.1	0.002

Table XXXIV

GAS-OFF PRODUCTS - SEALANT RTV-90

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)		
		Ethanol	Saturated Hydrocarbons*	Silicone Oil**
30	Air	23.4	0.7	0.4
60	"	18.2	0.2	0.5
90	"	12.5	0.4	0.3
30 + 30	"	15.1	0.04	0.08
30 + 30 + 30	"	1.2	0.09	0.3
30	Oxygen	9.0	0.02	0.02
60	"	9.3	0.02	0.02
90	"	2.9	0.5	N.D.
30 + 30	"	3.0	0.005	0.02
30 + 30 + 30	"	1.5	0.004	0.01

*Estimated C_{5-6} by Mass Spectrometry.

**See Analytical Data, Results and Discussion, Section II.

Table XXXV

GAS-OFF PRODUCTS—SILASTIC RTV-501

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material) n-Propanol	n-Butanol	Acetone
30	Air	20.4	0.08	0.10
60	"	14.2	0.07	0.50
90	"	18.4	0.07	0.12
30 + 30	"	12.7	0.06	0.04
30 + 30 + 30	"	3.8	0.02	N.D.
30	Oxygen	11.8	0.05	0.05
60	"	13.0	0.05	0.20
90	"	8.5	0.04	N.D.
30 + 30	"	5.5	0.05	0.04
30 + 30 + 30	"	0.8	0.005	N.D.

Table XXXVI

GAS-OFF PRODUCTS - SILASTIC C/R Q-3-0121

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)	
		Acetic Acid	Trimethyl Silanol
30	Air	2.5	0.06
60	"	0.2	0.01
90	"	3.1	0.008
30 + 30	"	2.7	0.01
30 + 30 + 30	"	1.5	0.01
30	Oxygen	1.8	0.008
60	"	0.5	0.01
90	"	2.2	0.05
30 + 30	"	1.1	0.003
30 + 30 + 30	"	0.2	0.002

Table XXXVII

GAS-OFF PRODUCTS - SILICONE EC 1663

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) Ethanol	Xylene	Trimethyl Silanol	C_{8-9}
30	Air	1.8	0.05	0.003	1.9
60	"	1.8	0.04	-	0.6
90	"	2.9	N.D.	-	N.D.
30 + 30	"	0.3	0.02	-	0.2
30 + 30 + 30	"	0.2	0.09	-	0.2
30	Oxygen	2.0	0.04	0.01	0.6
60	"	2.4	0.06	0.005	0.8
90	"	2.0	0.05	-	0.5
30 + 30	"	0.2	0.03	-	0.8
30 + 30 + 30	"	0.25	0.06	-	0.2

Table XXXVIII

GAS-OFF PRODUCTS - SEALER, EPON 828

Storage Time (Days)	Weight of Component (mg per 10 g Candidate Material)		
	Atmosphere	Methyl Isobutyl Ketone	Ethanol
30	Air	1.1	-
60	"	0.5	0.001
90	"	0.5	<0.001
30 + 30	"	1.1	0.003
30 + 30 + 30	"	0.6	<0.001
30	Oxygen	0.6	<0.001
60	"	0.5	0.05
90	"	0.7	0.09
30 + 30	"	0.8	0.04
30 + 30 + 30	"	0.8	0.002

Table XXXIX

GAS-OFF PRODUCTS - SILICONE PRIMER, A4004

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)					
		Ethanol	n-Butanol	Saturated* Hydrocarbon	Benzene	Toluene	Xylene
30		10.9	7.6	1.7	-	-	-
60		3.0	9.1	1.1	-	0.04	-
90		3.6	9.9	1.4	0.2	0.06	0.05
30 + 30		2.0	5.5	1.1	-	0.06	-
30 + 30 + 30		0.2	0.6	0.3	-	0.01	0.009
30	Oxygen	1.5	4.4	0.5	0.04	0.04	-
60		1.3	4.1	0.6	-	0.07	-
90		1.4	4.4	0.8	0.04	0.01	-
30 + 30		1.6	4.6	0.3	0.03	0.09	0.04
30 + 30 + 30		1.7	1.3	0.8	0.1	0.04	-

*Estimated C_{5-6} by Mass Spectrometry

Table XL

GAS-OFF PRODUCTS - SILICONE PRIMER, SS4004

Storage Time (Days)	Atmosphere	Wt. of Component (Mg per 10 g Candidate Material)					
		Ethanol	n-Butanol & 2-Propanol	Toluene	Xylene	C_3 Alkyl Benzene*	Acetone
30	Air	10.3	53	2.0	0.2	0.2	~ 2.0
60	"	5.0	45	4.5	<0.2	<0.2	~ 2.0
90	"	7.5	27	17.5	0.2	<0.2	~ 2.0
30 + 30	"	6.6	25	0.6	0.2	<0.2	~ 2.0
30 + 30 + 30	"	6.0	20	0.8	<0.2	<0.2	~ 2.0
30	Oxygen	13.0	86	5.6	0.7	0.2	~ 2.0
60	"	7.6	56	1.5	<0.2	<0.2	~ 2.0
90	"	16.5	102.4	2.6	1.0	<0.2	~ 2.0
30 + 30	"	4.6	25	1.6	0.2	<0.2	~ 2.0
30 + 30 + 30	"	4.0	23	1.1	0.2	<0.2	~ 2.0

*e.g., trimethyl, methyl-ethyl, n-propyl or isopropyl benzene.

Table XLI

GAS-OFF PRODUCTS - SILICONE PRIMER, EC-1694

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material)			
		Ethanol	n-Butanol	2-Propanol	Toluene
30	Air	4.6	14.2	26.4	2.7
60	"	4.6	6.5	29.6	3.4
90	"	8.2	10.0	18.9	7.9
30 + 30	"	1.8	15.5	15.3	0.7
30 + 30 + 30	"	0.4	13.8	8.3	0.1
30	Oxygen	4.1	11.1	21.7	3.3
60	"	4.6	10.4	27.9	4.2
90	"	7.2	12.6	25.4	6.5
30 + 30	"	2.3	10.7	14.8	2.9
30 + 30 + 30	"	0.8	9.6	10.5	1.1

Table XLII

GAS-OFF PRODUCTS - ELECTRICAL RESIN, SCOTCHCAST NO. 8

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material)				
		Acetone	Toluene	CO	n-Propanol	Benzene
30	Air	0.1	0.05	0.002	0.03	N.D.
60	"	0.1	0.03	0.003	0.08	0.003
90	"	0.03	0.02	< 0.001	0.05	0.002
30 + 30	"	0.02	0.01	0.001	0.02	<0.001
30 + 30 + 30	"	0.01	0.007	< 0.001	0.02	N.D.
30	Oxygen	0.1	0.06	0.005	0.02	N.D.
60	"	0.08	0.05	0.005	0.08	0.004
90	"	0.04	0.02	0.003	0.05	0.004
30 + 30	"	0.02	0.01	0.001	0.02	N.D.
30 + 30 + 30	"	0.005	0.003	0.003	0.02	N.D.

Table XLIII

GAS-OFF PRODUCTS - DC-325

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material Acetone	Trimethyl Silanol	Toluene
30	Air	0.005	0.005	0.002
60	"	0.1	0.006	0.006
90	"	0.02	0.006	0.002
30 + 30	"	0.008	0.003	0.004
30 + 30 + 30	"	N.D.	0.007	N.D.
30	Oxygen	0.02	0.02	0.002
60	"	0.02	0.009	0.003
90	"	0.02	0.01	0.001
30 + 30	"	0.02	0.02	0.001
30 + 30 + 30	"	0.007	0.02	0.001

Table XLIV

GAS-OFF PRODUCT - PLEXIGLAS NO. 2 CLEARMIL

Storage Time (Days)	Atmosphere	Wt. of Methylmethacrylate (Mg. per 10 g. Candidate Material)
30	Air	<0.03
60	"	<0.05
90	"	<0.01
30 + 30	"	N.D.
30 + 30 + 30	"	N.D.
30	Oxygen	<0.01
60	"	<0.02
90	"	<0.04
30 + 30	"	N.D.
30 + 30 + 30	"	N.D.

See Part 5.f, Results and Discussion, Section II.

Table XLV

GAS-OFF PRODUCTS - THERMOFIT TUBING SPLICER C/R 197-075

Storage Time (Days)	Atmosphere	Wt. of Component (mg per 10 g Candidate Material) C_4-C_6 Hydrocarbon(s)*
30	Air	<0.001
60	"	<0.001
90	"	<0.001
30 + 30	"	<0.001
30 + 30 + 30	"	<0.001
30	Oxygen	<0.001
60	"	<0.001
90	"	<0.001
30 + 30	"	<0.001
30 + 30 + 30	"	<0.001

*Determined by Mass Spectrometry.

Table XLVI

GAS-OFF PRODUCTS - ACETAL RESIN, DELRIN NO. 100

Storage Time (Days)	Atmosphere	Weight of Component (mg per 10 g Candidate Material) Formaldehyde	Acetaldehyde	Acetic Acid
30	Air	0.1	0.004	-
60	"	0.15	0.005	-
90	"	0.3	0.02	-
30 + 30	"	0.2	0.02	-
30 + 30 + 30	"	0.2	0.005	0.02
30	Oxygen	0.1	0.02	-
60	"	0.1	0.008	-
90	"	0.4	0.02	-
30 + 30	"	0.25	0.01	-
30 + 30 + 30	"	0.2	0.008	0.03

See Part 5.g, Results and Discussion, Section II.

APPENDIX II

REPRESENTATIVE MASS SPECTRAL DATA

FOR

GAS-OFF EXPERIMENTS

Mass spectral data were obtained using a Consolidated Electrodynamics 21-103C mass spectrometer. A heated inlet, maintained at a temperature of 135°C, was employed. Conditions were standardized at 70 volts ionizing potential and 10 microamperes ionizing current.

The observed spectrum is given in the first column in chart divisions. The contribution of each known component has been calculated in chart divisions using a reference spectrum. The source of the reference spectrum is listed at the foot of each table as:

CEC Serial No. - Keysort File of Mass Spectra Consolidated Electrodynamic Corp.

API Serial No. - American Petroleum Institute Research Project 44

MRC Spectra - Monsanto Research Corp. Spectra File

Table XLVII

REPRESENTATIVE MASS SPECTRAL DATA
FOR ADHESIVE, A-4000

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F	G, H, I, J, K
14	64.7				1.1		50.1	13.5
15	213.3		20.1	0.9	5.3		160.7	
16	144.0				0.3		6.6	137.1
17	925.0				0.2		6.5	918.3
18	3180.0						8.3	3171.7
19	81.8						77.5	
20	8.1							
21								
22	2.1							2.1
23								
24	1.4							
25	8.0					0.3	7.1	
26	55.3		11.0	1.5	0.5	1.3	37.4	
27	283.8		72.5	3.7	1.1	1.8	194.4	
28	121.2		5.8		2.8	0.4	18.3	93.9
29	152.1				2.0	1.0	138.3	
30	12.1				0.4		11.8	
31	78.7				0.7	0.1	64.7	
32	21.6							21.6
33	1.0							
34								
35								
36	3.9					0.1		
37	30.6		6.4	1.7		0.5	18.5	
38	57.7		21.0	3.6		0.5	27.8	
39	220.2		122.6	13.8	0.2	0.9	79.8	
40	29.9		13.4	1.6	0.1	0.2	12.0	2.6
41	111.6		17.9	1.5	0.5	0.5	85.3	
42	58.0				1.1	1.6	53.4	
43	237.3			1.3	3.4	22.9	217.2	
44	152.4			0.7	0.7	0.5	39.7	110.8
45	1131.0			3.6	18.7		1108.7	
46	29.1			2.6	1.4		25.4	
47	13.5				9.6			
48	0.8				0.5			
49	7.5		3.6	0.7	0.3			
50	58.2		46.9	4.5				
51	130.5		115.8	7.1				
52	60.2		54.0	1.8				
53	32.1		29.8	0.9	0.5			
54	3.0				0.1			
55	5.8				0.4			
56	4.5				0.2			
57	6.1				0.4	0.2		
58	6.2				0.2	6.2		
59	52.3	3.3			2.2	.0.2	37.9	
60	7.1				1.2		4.5	
61	13.1		5.1	1.5	2.0			

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F	G, H, I, J, K,
62	23.8		17.6	3.0	0.2			
63	57.5		48.5	6.5				
64	12.3		10.7	1.6				
65	70.3		59.5	9.6				
66	27.0		8.2	1.2				
67	4.5							
68								
69	1.5							
70	1.0							
71	1.8							
72	3.0				0.3			
73	30.5	31.4			1.0			
74	19.3	7.8	11.7	0.8	0.7			
75	93.0	4.6	11.3	0.5	76.6			
76	15.0		8.2	0.3	4.9			
77	106.2		99.9	0.9	2.8			
78	65.8		59.1					
79	52.5		56.0					
80	3.5		3.5					
81								
82								
83								
84	1.0							
85	2.4			0.4				
86	4.0			0.6				
87	6.4			0.4				
88	1.6			0.1				
89	20.2		15.7	3.0				
90	11.1		5.9	2.5				
91	831.0		756.6	74.4				
92	66.3		56.4	51.3				
93	2.3							
94								
95								
96	3.8							
97								
98	2.4							
99								
100								
101	3.0							
102	10.2		10.3					
103	42.0		43.0					
104	18.5		22.3					
105	180.0		182.3					
106	401.0		401.0					
107	35.5		38.0					
108	1.3							
109								

A - Silicone Oil (See Text, Results & Discussion)
B - Xylene (CEC Card No. 220)
C - Toluene (CEC Card No. 214)
D - Trimethyl Silanol (MRC Specta)
E - Acetone (CEC Card No. 318)
F - 2-Propanol (CEC Card No. 326)

G - Water)
H - Nitrogen)
I - Oxygen) Atmospheric
J - Carbon Dioxide) Contamination
K - Argon)

Table XLVII- Cont'd

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F	G,H,I, J,K	Mass No.	Spectrum of Mixture	Calculated Components				
125	1.0	1.6													
133	8.3	5.9													
147	129.9	9.5													
148	21.0														
149	14.1														
191	3.8	3.6													
193	2.5	3.9													
207	23.8	10.8													
249	1.3	2.0													
251	0.9	2.1													
265	1.9	2.3													
267	0.8	9.5													
281	32.7	32.7													
282	9.1	9.2													
283	5.8	5.9													

Table XLVIII

REPRESENTATIVE MASS SPECTRAL DATA FOR ADHESIVE, NO. 271

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E
14	27.4		3.7				62						
15	48.7		11.8	22.2			63						
16	186.5						64						
17	996						65						
18	3470						66						
19	10.9		5.7				67						
20	9.2						68						
21							69						
22	7.5						70						
23							71						
24							72						
25							73	10.0					10.0
26	9.8	1.0	2.7	2.1			74	3.8					4.0
27	37.9	1.9	14.2	4.6			75	323			323		
28	201		1.3	11.9			76	24.5			20.8		
29	38.8	2.0	10.1	8.6			77	15.5			11.8	0.7	
30	3.5		0.9	1.7			78						
31	18	7.5	4.7	3.1			79						
32	62.5						80						
33							81						
34							82						
35	2.8						83						
36	1.8						84						
37	3.8		1.3				85						
38	4.8		2.0				86						
39	16.3		5.9				87						
40	9.9		1.0				88						
41	25		6.2	2.1			89						
42	17.7		3.9	4.6			90						
43	99.9		15.9	14.3			91	4.8				4.8	
44	425		2.9	3.1			92	1.0				0.4	
45	163.2	2.7	81	78.9									
46	9.7	1.2	1.9	6.3			105	1.2				1.4	
47	4.4			40.6			106	2.2				2.5	
48	3.8												
49	1.9						133	4.0					4.0
50	1.0												
51	3.4						147	6.2					
52	1.2												
53	3.2						281	8.5					8.5
54	1.0						282	2.3					2.3
55	4.2						283	1.3					1.3
56	5.0												
57	6.8												
58	11.8												
59	12.9		2.3	9.4		1.0							
60	7.8		0.7	5.0									
61	9.4			8.6									

A - Ethanol (CEC Card No. 312)
B - 2-Propanol (CEC Card No. 326)
C - Trimethyl Silanol (MRC Spectra)
D - Xylene (CEC Card No. 220)
E - Silicone Oil (See Text, Results & Discussion)

Note: Lines at 43,57,58, mass no's. indicate C_4-C_5 Hydrocarbon also. Atmospheric Components CO_2, Argon, Water and some N_2 and O_2 present.

Table XLIX

REPRESENTATIVE MASS SPECTRAL DATA FOR RESIN, VERSAMID 125

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E,F G,H		Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E,F, G,H	
14	281.0	3.6	173.8				62						
15	814.0	8.2	592.5				63						
16	7490.0	1.6	6320.1		69.9		64						
17	8390.0	2.5	7900.1		489.9		65						
18	1701.0	10.6	27.0		1663.4		66						
19	3.7				2.7		67						
20	3.8						68						
21							69						
22							70						
23							71						
24							72						
25	1.6	0.8					73						
26	9.6	4.4					74						
27	24.1	11.0					75						
28	111.6	23.9			87.7		76						
29	19.6	6.1					77						
30	82.6	82.6					78						
31	7.1	1.4					79						
32	6.9				6.9		80						
33							81						
34							82						
35							83						
36							84						
37							85						
38	3.0	1.3					86						
39	8.7	1.8		1.6			87						
40	10.8	3.8			7.0		88						
41	15.4	3.9					89						
42	11.9	7.4					90						
43	16.6	2.5					91	9.6			9.6		
44	17.0	16.2			0.8		92	3.2			0.7		
45	11.0	15.5					93						
46							94						
47							95						
48							96						
49							97						
50	1.2			1.5			98						
51	2.4						99						
52	1.4						100						
53	2.1						101						
54	1.2						102						
55	2.5						103						
56	2.9						104						
57	5.2						105	1.8			2.3		
58	1.3						106	3.4			5.1		
59	1.0						107						
60							108						
61							109						

A - Ethyl Amine (API Serial No. 764)
B - Ammonia (API Serial No. 90)
C - Xylene (CEC Card No. 220)
D - Water
E - Nitrogen
F - Oxygen
G - Carbon Dioxide
H - Argon

D–H: Atmospheric Contamination

Table L

REPRESENTATIVE MASS SPECTRAL DATA FOR NEOPRENE, PHENOLIC EC-847

Mass No.	Spectrum of Mixture	Calculated Components: A	B	C	D*	E	F	G	H, I, J K, L
14	735.0								735.0
15	3500.0								
16	133.2								133.2
17	83.0								83.0
18	255.0								255.0
19	8.8								
20	17.3								
21									
22									
23									
24	25.9								
25	153.9	117.3	1.9						
26	745.0	443.6	14.2					6.4	
27	2190.0	618.1	43.7	2.7				19.8	
28	754.0	134.3	8.0		C_2H_4			6.7	605.0
29	1674.0	331.0	67.4		C_2H_5			18.3	
30	41.5	13.1	1.5					2.6	
31	50.0	44.0						106.7	
32	83.0							2.4	80.6
33									
34									
35									
36	63.5	44.8							
37	258.0	161.3	1.9					1.2	
38	333.0	179.0	2.4					1.8	
39	1350.0	294.0	6.2	10.2			2.6	5.6	
40	258.0	62.5	0.7					1.1	
41	2454.0	162.8	4.3					7.0	
42	2010.0	539.3	14.5					8.6	
43		7716.0	285.7		C_3H_7			4.0	
44	648.0	173.6	7.0						467.4
45	58.4		1.9	2.7				4.7	
46									
47									
48									
49									
50	58.0		1.7	3.3			3.5		
51	82.8			5.2			3.9		
52	39.4						3.8		
53	154.2								
54	68.0								
55	608.0		1.3						
56	1800.0								
57	1680.0	63.3			C_4H_9			1.6	
58	2091.0	2091.0							
59	87.0	72.5						10.4	
60	7.0							7.0	
61									

Mass No.	Spectrum of Mixture	Calculated Components: A	B	C	D	E	F
62							
63	18.0			4.8			
64							
65	24.0			7.0			
66							
67	42.8						
68	38.0						
69	318.0				C_5H_9		
70	250.5				C_5H_{10}		
71	480.0		2.1		C_5H_{11}		
72	46.0		46.0				
73	3.0		2.1				
74							
75							
76							
77	10.5						3.0
78	18.5						18.5
79							
80							
81							
82							
83	75.8						
84	219.0				C_6H_{12}		
85	130.0				C_6H_{13}		
86	106.8				C_6H_{14}		
87	12.0						
88							
89							
90							
91	56.5			54.6		1.9	
92	36.6			37.6			
93							
94							
95							
96							
97							
98	26.0				C_7H_{14}		
99							
100	26.5				C_7H_{16}		
101							
102							
103							
104							
105	0.4					0.5	
106	1.0					1.0	
107							
108							
109							

A - Acetone (CEC Card No. 318)
B - 2-Butanone (CEC Card No. 339)
C - Toluene (CEC Card No. 214)
D - Sat. Hydrocarbons
E - Xylene (CEC Card No. 220)
F - Benzene (CEC Card No. 212)

G - 1-Propanol (CEC Card No. 325)
H - Water
I - Nitrogen
J - Oxygen
K - Carbon Dioxide
L - Argon
(H – L) Atmospheric Contamination

* Hydrocarbon portion identified as 5 separate C_6 and C_7 hydrocarbons by collection of GLC fractions.

Table LI

REPRESENTATIVE MASS SPECTRAL DATA
FOR SILASTIC NO. 950

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
			B,C,D, E,F										
14	190.0		190.0				62						
15	6.6						63						
16	170.4		170.4				64						
17	756.0		756.0				65						
18	2620.0		2620.0				66						
19	4.2		4.2				67						
20	9.6						68						
21							69						
22	1.5		1.5				70						
23							71						
24							72						
25							73						
26	1.5						74						
27	2.9						75						
28	1086.0		1086.0				76						
29	10.6	C_2H_5	10.6				77						
30							78						
31	1.4						79						
32	240.3		240.3				80						
33							81						
34	1.0		1.0				82						
35	0.7						83						
36	2.5						84						
37	0.4						85						
38	1.2						86						
39	1.3						87						
40	19.4		19.4				88						
41	1.4						89						
42	1.5						90						
43	16.1	C_3H_7					91						
44	59.3		59.3				92						
45	2.4		2.4				93						
46							94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55	0.9						103						
56	0.4						104						
57	1.5	C_4H_9					105						
58	3.8	C_4H_{10}					106						
59							107						
60							108						
61							109						

A - Sat. Hydrocarbon
B - Water)
C - Nitrogen)
D - Oxygen) Atmospheric
E - Carbon Dioxide) Contamination
F - Argon)

Table LII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILASTIC S2007

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G, H,I
14	562.0			293.4	275.0	
15	1170.0			476.3	666.0	
16	2445.0			29.4	99.1	2316.5
17	814.0			49.2		764.8
18	2670.0			37.9		2632.1
19	139.2			127.8		
20	8.3					
21						
22	365.0					365.0
23						
24	46.7			22.6	29.6	
25	179.4			104.0	86.2	
26	559.0			421.1	156.4	
27	1007.0			1001.1	78.0	
28	2688.0			280.5	63.3	2344.2
29	2679.0			1087.3	1583.0	
30	273.0			249.5	18.0	
31	4030.0			4030.0		
32	63.8			49.6		14.2
33	8.5					
34						
35						
36						
37						
38						
39	6.3					
40	48.9				15.7	33.2
41	108.0			43.1	64.0	
42	289.0			140.2	148.8	
43	813.0			346.6	419.0	
44	>10,000			67.7	713.1	>10,000
45	1698.0			1452.0	20.9	
46	637.0			627.0		
47	61.3					
48						
49						
50	6.2					
51						
52						
53						
54						
55	5.3					
56						
57						
58						
59	10.0	30.0				
60						
61	10.3					

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G, H,I
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72	10.0					
73	189.6	287.0				
74	15.5	71.7	1.9			
75	24.2	41.9	3.3			
111	9.0		6.2			
125	9.0	15.0				
133	31.5	53.8				
134	5.0					
146	19.0		19.0			
147	5.0	86.7				
148	13.0		12.3			
177	6.8					
191	17.5	32.9				
193	16.6	35.9				
207	19.8	98.7				
249	12.1	17.9				
251	8.0	19.4				
265	16.0	20.9				
267	19.5	86.7				
281	299.0	299.0				
282	85.0	83.7				
283	51.0	53.8				

A - Silicone Oil (See Text, Results & Discussion)
B - Dichlorobenzene (MRC Spectra)
C - Ethanol (CEC Card No. 312)
D - Acetaldehyde (CEC Card No. 288)

E - Water)
F - Nitrogen)
G - Oxygen) Atmospheric
H - Carbon Dioxide) Contamination
I - Argon)

Table LIII

REPRESENTATIVE MASS SPECTRAL DATA
FOR SILASTIC 950-4-400

Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G			Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G		
14	13.5	5.5		8.0			62						
15	24.3	8.9					63						
16	313.0	0.6		312.4			64						
17	730.0	0.9		729.1			65						
18	2484.0	0.2		2483.8			66						
19	8.9	2.4		6.5			67						
20	5.5						68						
21							69						
22	35.2			35.2			70						
23							71						
24	0.9	0.4					72						
25	2.8	1.9					73						
26	11.2	7.9					74						
27	29.3	18.7					75						
28	247.5	5.2		242.3			76						
29	32.7	20.3					77						
30	7.3	4.7					78						
31	75.4	75.4					79						
32	9.2	0.9		8.1			80						
33							81						
34							82						
35							83						
36	0.5						84						
37	1.5						85						
38	2.2						86						
39	6.0						87						
40	4.1			4.1			88						
41	6.3	0.8					89						
42	7.1	2.6					90						
43	42.5	6.5					91						
44	1983.0	1.3		1981.7			92						
45	83.6	27.2		56.4			93						
46	19.3	11.7					94						
47	0.7						95						
48							96						
49							97						
50	1.0						98						
51	1.2						99						
52	0.8						100						
53	0.9						207	0.7	0.5				
54							281	1.6	1.6				
55	1.9						282	0.2	0.4				
56	1.2												
57	1.9												
58	6.0												
59	2.9		0.2										
60													
61													

A - Ethanol (CEC Card No. 312)
B - Silicone Oil (See Text, Results & Discussion)
C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric Contamination
F - Carbon Dioxide)
G - Argon)

Table LIV

REPRESENTATIVE MASS SPECTRAL DATA FOR SILASTIC 9711-2-480

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C,D,E					A	B			
14	7.2						62						
15	11.0						63						
16	516.0			516			64						
17	483.0			483			65						
18	1650.0			1650			66						
19	3.0						67						
20	4.1						68						
21							69						
22	73.9						70						
23							71						
24							72						
25							73	2.3	10.0				
26	3.4						74	0.2	2.5				
27	7.8		0.2				75	1.2	1.5				
28	482.0			482			76						
29	18.2						77	0.4		0.3			
30	4.1						78	1.5		0.2			
31	7.3						79	0.3		0.2			
32	10.0			10.0			80						
33							81						
34							82	1.2					
35	2.1						83						
36							84						
37	1.3						85						
38	1.2						86						
39	3.9		0.4				87	1.3					
40	6.5						88						
41	4.5						89	0.4					
42	2.8						90						
43	21.2			4270			91	2.4		2.4			
44	4270.0			43			92			0.2			
45	56.6												
46	17.6						96	5.1	0.7				
47	3.6						105	0.6		0.6			
48	1.4						106	0.6		1.3			
49	1.0						133	3.2	1.9				
50	1.1						177	0.8					
51	1.0		0.4				191	2.8	1.1				
52	0.6		0.2				193	1.4	1.2				
53							207	29.1	3.4				
54							208	6.2	0.7				
55	2.2						209	3.5	0.4				
56	1.3						265	0.3	0.7				
57	2.8						267	0.3	3.0				
58	3.5						281	10.4	10.4				
59	1.1	1.0					282	2.6	2.9				
60							283	1.7	1.9				
61													

A - Silicone Oil (See Text, Results & Discussion)
B - Xylene (CEC Card No. 220)
C - Water
D - Nitrogen
E - Oxygen
F - Carbon dioxide

Table LV

REPRESENTATIVE MASS SPECTRAL DATA
FOR WIRE (MIL-W-16878-C), TYPE E 22-W-9 5M114E22W9

Mass No.	Spectrum of Mixture	Calculated Components: Hydro-Carbon					Mass No.	Spectrum of Mixture	Calculated Components				
14							62						
15							63						
16	249)						64						
17	1260)	(H_2O)					65						
18	3160)						66						
19	10.8						67						
20	9.8						68						
21							69	1.0	C_5H_{10}				
22	8.1	($CO_2(++)$)					70	1.2	C_5H_{11}				
23							71	0.8	C_5H_{12}				
24							72	0.5					
25							73						
26							74						
27	4.1						75						
28	83.4	(N_2)					76						
29	4.5						77						
30							78						
31	4.8						79						
32	12.2	(O_2)					80						
33							81						
34							82						
35							83						
36							84						
37							85						
38							86						
39	2.0						87						
40	3.0	(Argon)					88						
41	5.0	C_3H_5					89						
42	1.9						90						
43	5.7	C_3H_7					91						
44	457	CO_2					92						
45	6.5						93						
46	2.0						94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55	2.0	C_4H_7					103						
56	2.5	C_4H_8					104						
57	5.0	C_4H_9					105						
58							106						
59							107						
60							108						
61							109						

Table LVI

REPRESENTATIVE MASS SPECTRAL DATA
FOR VELVET COATING NO. 104-C 10 BLACK

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G, H,I
14	97.5			2.3		95.2
15	340.0			3.8		
16	807.0			0.2		806.8
17	119.4			0.4		119.0
18	390.0			0.3		389.7
19	6.5			1.0		
20	2.8					2.8
21						
22	125.7					125.7
23						
24	3.0			0.8		
25	14.2			3.3	2.3	
26	82.0	38.5		2.2	8.8	
27	229.8	117.8		7.9	12.2	
28	975.0	21.5			2.7	950.8
29	549.0	177.5		8.6	6.6	
30	55.0	4.0		2.0	0.3	
31	36.4	4.4		32.0	0.9	
32	226.2			0.4		225.8
33	3.8					
34						
35						
36	2.8				0.9	
37	14.9				3.2	
38	19.2	6.2			3.5	
39	61.3	17.2	2.8		5.8	
40	18.5	2.0			1.2	15.3
41	76.7	12.6		0.3	3.2	
42	91.5	37.9		1.1	10.7	
43	958.0	727.3		2.8	152.8	
44	7400.0	19.9		0.5	3.4	7376.2
45	138.0	12.7		11.5		
46	32.7			5.0		
47						
48						
49	3.8					
50	8.3		0.9			
51	7.0	2.4	1.4			
52	2.5	0.9				
53	8.0	4.1				
54	3.0	1.5				
55	15.2	4.1				
56	13.0	1.4				
57	72.6	44.4			1.3	
58	43.0	1.6			41.4	
59	5.0				1.4	
60	10.8					
61	1.0					

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	
62	1.0					
63	2.0					
64	1.0					
65	2.5		1.9			
66						
67	1.5					
68	1.0					
69	3.9					
70	5.8					
71	14.8	5.2				
72	120.0	120.0				
73	6.0	5.6				
74	3.8					
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91	15.0		15.0			
92	9.3		10.3			
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						
106						
107						
108						
109						

A - 2 Butanone (API Serial No. 429)
B - Toluene (CEC Card No. 214)
C - Ethanol (CEC Card No 312)
D - Acetone (CEC Card No 318)

E - Water)
F - Nitrogen) Atmospheric
G - Oxygen) Contamination
H - Carbon Dioxide)
I - Argon)

Table LVII

REPRESENTATIVE MASS SPECTRAL DATA
FOR CLASS H SILICONE IMPREGNATING VARNISH, NO. 997

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C	D	E, F, G, H, I			A	B	C	D	E, F, G, H, I
14	32.8			6.9		25.9	62	1.0	0.8				
15	63.5		0.7	11.3			63	4.8	2.1				
16	467.0			0.7		466.3	64	1.0	0.5				
17	870.0			1.2		868.8	65	4.0	2.6				
18	2961.0			0.9		2960.1	66						
19	7.4			3.0			67						
20	6.8						68						
21							69						
22	56.5						70	1.4					
23							71						
24	3.5			0.5	0.8		72	2.7					
25	14.0			2.5	3.6		73	14.5		0.8			
26	54.3	0.5	2.1	10.0	18.4		74	4.0	0.5	2.5			
27	109.2	3.1	1.7	23.7	50.0		75	2.9	0.5	0.8			
28	522.0			6.6	59.3	456.1	76	3.5	0.4	1.0			
29	209.4			25.7	85.9		77	11.7	4.3	7.7			
30	22.3			5.9	4.9		78	50.0	2.5	47.5			
31	97.8			95.4	2.4		79	5.5	2.4	3.0			
32	10.6			1.2		9.4	80						
33							81						
34							82	1.0					
35	2.5						83	12.3					
36	1.7				0.6		84						
37	8.0		2.3		2.2		85	8.0					
38	8.5	0.9	2.9		2.3		86						
39	24.0	5.3	6.7		3.5		87	1.6					
40	9.0	0.6			0.9	7.5	88						
41	17.1	0.8		1.0	1.7		89	1.2	0.7				
42	17.5			3.3	3.3		90						
43	48.5			8.2	9.7		91	32.6	32.6				
44	3440.0			1.6	2.6	3435.6	92		2.4				
45	75.3			34.4			93						
46	25.5			14.8			94						
47	4.5						95						
48	2.5						96						
49	2.9		1.5				97						
50	12.2	2.0	9.0				98						
51	15.6	5.0	10.1				99						
52	11.8	2.3	9.7				100						
53	2.9	1.3			0.8		101						
54							102						
55	6.0				1.4		103	2.0	1.9				
56	4.3		1.7		0.7		104	0.7	1.0				
57	12.3				9.3		105	5.2	7.9				
58	32.1				32.1		106	14.3	17.3				
59	3.5				1.3		107						
60	1.0						108						
61	1.0						109						

A - Xylene (CEC Card No. 220)
B - Benzene (CEC Card No. 212)
C - Ethanol (CEC Card No. 312)
D - Propionaldehyde (CEC Card No. 319)

E - Water
F - Nitrogen
G - Oxygen
H - Carbon Dioxide
I - Argon

} Atmospheric Contamination

Table LVIII

REPRESENTATIVE MASS SPECTRAL DATA FOR 620 LIGHT GULL GRAY XA-193

Mass No.	Spectrum of Mixture	Calculated Components: A	B	C	D	E	F	G	H,I,J,K,L
14	34.0		6.6						27.4
15	129.0	1.2	21.2			0.8	15.5	37.1	
16	19.5								19.5
17	78.0								78.0
18	275.0								275.0
19	9.0		10.2						
20									
21									
22									
23									
24									
25									
26	73.8	1.0	4.9		5.0	2.3	24.9	20.4	
27	275.0	2.4	25.6		15.4	1.8	61.7	133.7	
28	43.6		2.4		2.8			10.6	27.8
29	73.5	2.6	18.2	C_2H_5	23.7				
30									
31	18.3	9.8	8.5						
32	5.0								5.0
33									
34									
35									
36									
37	59.0		2.4		0.7	0.4	28.2	11.9	
38	126.0		3.7		0.8	3.2	59.5	38.8	
39	510.0		10.5		2.2	7.3	229.1	226.2	
40	57.9		1.6		0.3		25.6	24.7	5.7
41	105.0		11.2		1.5		24.9	33.1	
42	27.0		7.0		5.1				
43	189.0	0.8	28.6	C_3H_7	100.6		21.3		
44	89.0		5.2		2.5		12.0		69.3
45	165.0	3.5	146.2		0.7		60.0		
46	48.5	1.5	3.3				42.5		
47									
48									
49	26.4					1.7	11.2	6.7	
50	194.7					9.9	74.3	86.6	
51	365.0					11.0	118.0	213.6	
52	142.5					10.6	29.3	99.7	
53	72.7					0.4	14.3	55.0	
54									
55	37.1				0.5				
56	17.5								
57	38.5			C_4H_7					
58	8.0								
59	5.0		5.0						
60									
61	43.5					0.4	25.1	9.4	

Mass No.	Spectrum of Mixture	Calculated Components: C	D	E	F	G	H,I J,K
62	95.4			0.4	50.1	32.5	
63	216.3			1.9	108.4	89.5	
64	48.0				25.9	19.7	
65	279.0				158.9	109.7	
66	36.1				20.1	15.2	
67							
68							
69	12.0						
70	10.0						
71	11.5	C_5H_{11}	0.7				
72	16.2	C_5H_{12}	16.2				
73	10.5		0.8				
74	44.0			2.7	13.1	21.6	
75	30.5			1.0	8.5	20.9	
76	25.5			1.1	5.4	15.2	
77	210.0			8.4	14.5	184.3	
78	161.0			52.0		109.0	
79	99.0			3.3		103.3	
80	8.0					6.4	
81							
82							
83	11.5						
84	9.0						
85	19.0	C_6H_{13}			7.3		
86	18.0				10.6		
87	13.5				6.7		
88							
89	82.2				49.2	29.0	
90	85.0				41.9	10.9	
91	2628.0				1232.0	1396.0	
92	910.0				848.8	104.1	
93	70.3				67.0		
94							
95							
96							
97	18.4						
98							
99							
100							
101							
102	17.0					18.9	
103	73.0					79.3	
104	35.0					41.1	
105	340.0					336.4	
106	740.0					740.0	
107	62.0					70.1	
108							
109							

A - Ethanol (CEC Card No. 312)
B - 2-Propanol (CEC Card No. 326)
C - C_5 - C_{10} Saturated Hydrocarbon
D - 2-Butanone (CEC Card No. 339)
E - Benzene (CEC Card No. 212)
F - Toluene (CEC Caad No. 214)
G - Xylene (CEC Card No. 220)
H - Water
I - Nitrogen
J - Oxygen
K - Carbon Dioxide
L - Argon

(H - L: Atmospheric Contamination)

Table LIX

REPRESENTATIVE MASS SPECTRAL DATA
FOR 3615 GRAY XA-194

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F,G,H I,J
14	33.8				0.9	6.9	26.0
15	82.0	14.5	8.7		0.8	11.3	
16	336.0				0.1	0.7	335.2
17	255.9				0.3	1.2	254.4
18	870.0				0.8	0.9	868.3
19	10.0				0.5	3.0	
20	3.0						3.0
21							
22	4.8						4.8
23							
24							
25	6.8			0.2	0.4	2.5	
26	49.0	7.9	13.9	1.5	2.8	10.0	
27	67.5	52.1	34.4	4.8	8.5	23.8	
28	440.0	4.1		0.9	2.9	6.6	425.5
29	120			7.3	7.9	25.7	
30	11.0			0.2	1.1	5.9	
31	141.0				45.7	95.3	
32	38.0				1.0	1.2	35.8
33							
34							
35							
36	2.5						
37	29.5	4.6	15.7	0.2	0.5		
38	60.5	15.1	33.2	0.3	0.8		
39	270.0	88.0	127.7	0.7	2.4		
40	38.5	9.6	14.5	0.1	0.5		13.8
41	139.5	12.9	13.9	0.5	3.0	1.0	
42	48.5			1.6	3.7	3.3	
43	190.0		11.9	31.1	1.7	8.2	
44	2754.0		6.7	0.8	0.3	1.6	2744.6
45	168.0		33.4	0.2	2.0	34.3	98.1
46	46.4		23.7			14.8	
47							
48							
49	11.8	2.6					
50	90.9	33.7		0.2			
51	163.5	83.1					
52	59.0	38.8					
53	8.5	21.4					
54	7.2						
55	78.0			0.1			
56	57.5						
57	94.0				0.7		
58	6.5				0.2		
59	3.0				4.5		
60	3.0				3.0		
61	21.0	3.6	14.0				
62	45.2	12.7	27.9				
63	102.0	34.8	60.4				
64	24.0	7.7	14.4				
65	46.0	43.7	88.6				
66	19.5	5.9	11.2				
67	11.2						
68	6.5						
69	32.0						
70	33.0						
71	39.0			0.2			
72	5.0			5.0			
73	5.0			0.2			
74	20.5	8.4	7.3				
75	14.0	8.2	4.7				
76	11.0	5.9	3.0				
77	87.0	71.7	8.1				
78	70.0	42.4					
79	44.0	40.2					
80	4.0	2.5					
81	6.5						
82	9.0						
83	22.0						
84	19.5						
85	34.5		4.1				
86	10.5		5.9				
87	7.0		3.7				
88							
89	37.8	11.3	27.4				
90	47.0	4.2	23.3				
91	1230.0	543.4	686.6				
92	470.0	40.5	473.1				
93	32.5		37.4				
94							
95	4.5						
96	4.0						
97	31.0						
98	8.0						
99	5.5						
100							
101							
102	7.0	7.4					
103	30.0	30.9					
104	15.0	16.0					
105	123.0	130.9					
106	288.0	288.0					
107							
108							
109							

A - Xylene (CEC Card No. 220)
B - Toluene (CEC Card No. 214)
C - Methyl Ethyl Ketone (CEC Card No. 339)
D - 1-Propanol (CEC Card No. 325)
E - Ethanol (CEC Card No. 312)

F - Water, G - Nitrogen, H - Oxygen, I - Carbon Dioxide, J - Argon: Atmospheric Contamination

Sat. hydrocarbons also present

Table LX

REPRESENTATIVE MASS SPECTRAL DATA FOR SILVER MARKING INK NO. 1448 (WITH CRESYLIC ACID)

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E,F, G,H	
14	109.8	3.3			106.5	
15	208.5	9.6				
16	201.0				201.0	
17	906.0				906.0	
18	3180.0				3180.0	
19	13.3	2.1				
20	9.0					
21						
22	9.8					
23						
24	1.5					
25	5.0					
26	9.0	4.3		0.7		
27	10.0	19.0		0.9		
28	526.0	5.3			520.7	
29	300.0	35.6	198.6			
30	18.0	2.4	17.3			
31	390.0	69.2	320.8			
32	32.3	1.8			30.5	
33	1.5	0.7				
34						
35						
36						
37						
38						
39	3.5					
40	12.0				12.0	
41	20.0	1.7	36.3			
42	44.8	2.0	49.9	0.8		
43	830.0	9.4	820.7	11.4		
44	725.0	2.6	9.6		712.8	
45	104.4	18.2	81.4			
46	6.3					
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57	6.2					
58	17.3		14.2	3.1		
59	279.6	34.4	253.6			
60	11.3	1.3	11.8			
61	23.3	1.3	22.2			

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E,F, G,H	
62						
63						
64						
65						
66						
67						
68						
69						
70	5.9		8.4			
71						
72	197.4	9.4	173.1			
73	27.2		26.8			
74	14.0		12.4			
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87	44.0		41.5			
88	33.9		28.5			
89	8.0		7.1			
90						
91						
92						
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						
106						
107						
108						
109						

A - 2-Ethoxyethanol (API Serial No. 1146)
B - 2-Ethoxyethyl Acetate (MRC Specta)
C - Acetone (CEC Card No. 318)

D - Water)
E - Nitrogen)
F - Oxygen) Atmospheric
G - Carbon Dioxide) Contamination
H - Argon)

Table LXI

REPRESENTATIVE MASS SPECTRAL DATA FOR LATEX FOAM RUBBER

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C,D,E,F,G					A	B			
14							62						
15							63						
16	325.			325			64						
17	1194			1194			65						
18	4640			4640			66						
19	7.0						67						
20	9.7						68						
21							69						
22	6.5						70						
23							71						
24							72						
25							73						
26							74						
27							75						
28	165	2.8		263			76	3.5		3.5			
29	4						77						
30	2.5	1.7					78						
31	5.0	0.5					79						
32	32.8	19.9		13			80						
33							81						
34							82						
35							83						
36							84						
37							85						
38							86						
39							87						
40	3.0			3.0			88						
41							89						
42							90						
43	4.0						91						
44	365			365			92						
45	5.0			3.6			93						
46							94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60	33.9	33.9					108						
61							109						

A - Carbonyl Sulfide (API Serial No. 174)
B - Carbon Disulfide (API Serial No. 92)
C - Water)
D - Oxygen)
E - Nitrogen) Atmospheric
F - Carbon Dioxide) Contamination
G - Argon)

Table LXII

MASS SPECTRAL DATA FOR LATEX FOAM RUBBER PRODUCTS REMOVED WHILE HEATING UNDER VACUUM

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C,D,E, F,G					A	B			
14	41.4			35.9			62	90.6	89.3				
15	82.4						63	2.2					
16	369.0	25		365			64	9.0		8.8			
17	873.0			870			65						
18	2850			2873			66						
19	5.3						67						
20	6.0						68						
21							69						
22	41.1	0.8		33.1			70						
23							71						
24							72						
25	7.1						73						
26	35.1						74						
27	70.3						75						
28	597.0	163		434			76	627.0		627			
29	67.0	1.9					77	13.8		16.3			
30	159.0	2.0					78	68.9		53.9			
31	15.1	4.0					79						
32	1482.0	1137	134.8	210			80						
33	12.3	1.0	1.2				81						
34	67.0	50.5	5.6	1.0			82						
35							83						
36	4.1						84						
37	5.0						85						
38	50.6						86						
39	32.4						87						
40	11.4						88						
41	46.2						89						
42	39.5						90						
43	225.9						91						
44	1950.0	58	111.6	1789			92						
45	32.3	1.0	1.9	20.4			93						
46	16.1	2.9	5.0	7.5			94						
47	4.1						95						
48	3.5	1.9					96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55	13.0						103						
56	21.0						104						
57	27.3						105						
58	40.0						106						
59	1.6						107						
60	1941.0	1941					108						
61	40.4	33.0					109						

A - Carbonyl Sulfide (API Serial No. 174)
B - Carbon Disulfide (API Serial No. 92)

NOTE: Since these components are not products of a scheduled Gas Off Study, no attempt has been made to account for many of the lines.

C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric
F - Carbon Dioxide) Contaminants
G - Argon)

Table LXIII

REPRESENTATIVE MASS SPECTRAL DATA FOR LOCKFOAM C-605 (R&T)

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B, C, D, E										
14	6.0		5.9				62						
15	1.2						63						
16	1120	1068	28.3				64						
17	184		184				65						
18	625		625				66						
19	1.0						67						
20	2.0		1.0				68						
21	-						69						
22	177.6	171					70						
23	2.0						71						
24							72						
25							73						
26							74						
27							75						
28	990	956	40				76						
29	10	9.0					77						
30							78						
31							79						
32	11.3		11.3				80						
33							81						
34							82						
35							83						
36							84						
37							85						
38							86						
39							87						
40	9.0		9.0				88						
41							89						
42							90						
43							91						
44	9230	9230					92						
45	109.2	105					93						
46	30.3	33					94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60							108						
61							109						

A - Carbon Dioxide (CEC Card No. 423)
B - Water
C - Nitrogen
D - Oxygen
E - Argon

(B–E: Atmospheric Contamination)

NOTE: CO_2 is greatly in excess of that normally present in the atmosphere.

Table LXIV

REPRESENTATIVE MASS SPECTRAL DATA
FOR LOCKFOAM E-302 (R&T)

Mass No.	Spectrum of Mixture	Calculated Components A	B,C,D, E,F				Mass No.	Spectrum of Mixture	Calculated Components A				
14							62						
15							63						
16	820		820				64						
17	261		261				65						
18	898		898				66	252	244				
19	15.2	15					67						
20	10.8						68	80.3	78.7				
21							69						
22	44						70	11.0	10.5				
23							71						
24							72	7.2	7.0				
25							73						
26							74						
27	6.8						75						
28	85.5		85.5				76						
29	15.9						77						
30							78						
31	261	154.5					79						
32	19		19				80						
33							81						
34							82	68.5	68.0				
35	286	268					83						
36	40	33.3					84	44	44.2				
37	80	79.3					85						
38							86	7.3	7.2				
39							87						
40	10.5		10.5				88						
41	14.5						89						
42	9.0						90						
43	16.8	10.8					91						
44	7410	10.9	7410				92						
45	87		74				93						
46	31						94						
47	228.6	202					95						
48							96						
49	72	65					97						
50	33	32.1					98						
51	21.0	16.6					99						
52							100						
53							101	1500	1500				
54							102						
55							103	955	960				
56							104						
57							105	154.5	150				
58													
59							117	34.5	27.5				
60							119	33.1	26.4				
61							121	10.8	8.5				

A - Trichlorofluoromethane (Freon -11) (API Serial No. 1641)
B - Carbon Dioxide)
C - Water)
D - Nitrogen)) Atmospheric
E - Oxygen)) Contaminants
F - Argon))

Table LXV

REPRESENTATIVE MASS SPECTRAL DATA FOR FLUOROLUBE OIL GRADE FS-5

Mass No.	Spectrum of Mixture	Calculated Components				
			A			B, C, D, E, F
14	28.1					28.1
15	2.2					
16	183.0					183.0
17	835.0					835.0
18	2844.0					2844.0
19	5.7					
20	8.4					
21						
22	8.4					8.4
23						
24	0.5					
25	0.4					
26	1.5					
27	6.1					
28	247.6					247.6
29	8.4					
30	0.9					
31	103.5		CF			
32	121.5					121.5
33						
34	0.5					
35	18.1					
36	4.2					
37	5.7					
38	1.6					
39	2.6					
40	6.6					6.6
41	4.5					
42	1.8					
43	14.8					
44	458.0					458.0
45	6.1					
46	2.1					
47	20.0					
48	0.9					
49	6.6					
50	10.7					
51	2.1					
52						
53						
54						
55	5.7					
56	0.6					
57	1.8					
58	1.9					
59	0.9					
60						
61	0.7					

Mass No.	Spectrum of Mixture	Calculated Components				
			A			
62	3.8					
63						
64						
65						
66	28.9		$CC\ell F$			
67	2.7			$C\ell_{35}$	$C\ell_{37}$	
68	9.3		$CC\ell F$			
69	140.1		CF_3			
70	2.1					
71	1.8					
72						
73						
74	9.0					
75	0.9					
76						
77	0.6					
78	3.8					
79	0.8					
80	1.1					
81	3.3					
82	6.0					
83	3.2					
84	3.8					
85	435.0		$CF_2C\ell$			
86	6.0			$C\ell_{35}$	$C\ell_{37}$	
87	138.6		$CF_2C\ell$			
88	1.5					
89	0.5					
90	2.9					
91						
92	1.1					
93	27.8		C_3F_3			
94	1.5					
95						
96	0.8					
97	4.9					
98	0.6					
99	1.6					
100	13.1					
101	348.0					
102	3.4		$CC\ell_2F$			
103	219.9					
104	2.3		$CC\ell_2F$	$C\ell_{35}$,	$C\ell_{37}$	
105	35.7					
106	0.6		$CC\ell_2F$			
107						
108						
109	17.8		$C_3C\ell F_2$	$C\ell_{35}$		

A - Ionic Species Corresponding to Mass Spectral Lines
B - Water)
C - Nitrogen)
D - Oxygen) Atmospheric Contamination
E - Carbon Dioxide)
F - Argon)

Table LXV - Cont'd

Mass No.	Spectrum of Mixture	Calculated Components				
			A			
110	0.7					
111	5.8		C_3ClF_2	Cl_{37}		
112	5.1					
113	1.9					
115	1.0					
116	68.3		C_2ClF_3			
117	4.9			Cl_{35}	Cl_{37}	
118	22.2		C_2ClF_3			
119	18.3					
121	1.1					
124	2.3					
125	2.1					
127	1.5					
128	1.1					
129	1.2					
130	0.7					
131	33.0		C_3F_5			
132	11.9					
133	0.9					
134	6.9					
135	84.0		C_2ClF_4			
136	3.0			Cl_{35}	Cl_{37}	
137	27.4		C_2ClF_4			
138	0.7					
140	0.9					
141	0.6					
142	0.7					
143	2.8					
147	15.8		C_3ClF_4			
148	2.5			Cl_{35}	Cl_{37}	
149	17.0		C_3ClF_4			
150	1.8					
151	14.8		$C_2Cl_2F_3$			
152	1.4			Cl_{35}	Cl_{37}	
153	31.8		$C_2Cl_2F_3$			
154	0.8					
155	5.9					
159	1.5					
161	0.9					
163	18.7		$C_3Cl_2F_3$			
164	1.1			Cl_{35}	Cl_{37}	
165	11.8		$C_3Cl_2F_3$			
166	1.9					
167	4.9					
168	0.8					
169	5.9					
171	1.1					
178	1.4					

Mass No.	Spectrum of Mixture	Calculated Components				
			A			
179	4.3					
180	0.6					
181	5.6					
182	1.2					
183	1.6					
184	0.7					
185	32.0		C_3ClF_6			
186	1.5			Cl_{35}	Cl_{37}	
187	10.6		C_3ClF_6			
193	1.2					
197	4.3					
198	1.1					
199	2.6					
200	1.9					
201	33.0		$C_3Cl_2F_5$			
202	3.2			Cl_{35}	Cl_{37}	
203	21.0		$C_3Cl_2F_5$			
204	1.2					
205	3.8					
209	1.0					
213	3.8					
215	2.3					
216	0.7					
217	8.1					
219	7.7					
221	2.4					
229	2.8					
231	3.1					
232	0.5					
233	1.4					
235	1.8					
237	0.6					
243	0.6					
247	1.0					
251	1.5					
253	1.1					
259	0.4					
263	0.8					
265	0.5					
267	1.1					
269	1.0					
285	0.6					
293	0.8					

A - Ionic Species Corresponding to Mass Spectral Lines

Table LXVI

REPRESENTATIVE MASS SPECTRAL DATA FOR FLUOROLUBE GREASE GRADE GR-544, TYPE LG

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	
14	21.0					21.0	62						
15	24.6						63						
16	159.0					159.0	64						
17	1110.0					1110.0	65						
18	3850.0					3850.0	66	0.7				CClF	
19	9.0						67	0.4					$Cl_{35}\ Cl_{37}$
20							68	0.3				CClF	
21	1.0						69	7.2				CF_3	
22							70						
23							71						
24							72	1.8					
25	2.0	0.7					73	2.0					
26	18.0	9.0					74	1.2					
27	99.0	71.3					75						
28	157.5	23.3				134.2	76	1.4					
29	67.5	43.1					77	0.8			0.7		
30	5.5	3.2					78	4.2			4.2		
31	196.8	141.4			CF		79						
32	40.4	2.2				38.2	80						
33	11.5	11.4					81						
34							82						
35							83	3.4					
36							84						
37	4.5	2.0					85	12.7				CF_2Cl	
38	7.5	3.7					86						$Cl_{35}\ Cl_{37}$
39	35.3	22.5		0.6			87	3.8				CF_2Cl	
40	11.8	5.5				6.3	88						
41	102.0	87.2					89						
42	52.0	44.4					90						
43	108.0	85.0					91	0.7		0.7			
44	58.0	5.9				52.1	92						
45	17.3	9.2					93	0.9				$C_3\ F_3$	
46	1.5	0.6					94						
47	2.0						95						
48	0.8						96						
49	1.5						97						
50	3.5	1.1		0.8			98						
51	2.5	1.0		0.9			99						
52	1.5	0.3		0.9			100						
53	2.5	1.4					101	7.2				CCl_2F	
54	1.5	1.3					102						
55	18.4	16.4					103	3.6				CCl_2F	$Cl_{35}\ Cl_{37}$
56	114.3	114.0					104						
57	10.5	8.1					105	0.7				CCl_2F	
58	2.2						106						
59	5.8						107						
60	6.0						108						
61							109						

A - 1-Butanol (CEC Card No. 346)
B - Toluene (CEC Card No. 214)
C - Benzene (CEC Card No. 212)
D - Ionic Species Corresponding to Mass Spectral Lines

E - Water)
F - Nitrogen)
G - Oxygen)Atmospheric
H - Carbon Dioxide)Contamination
I - Argon)

Table LXVI- Cont'd

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
					D								
116	1.6				C_2ClF_3								
117	0.5					$Cl_{35}\ Cl_{37}$							
118	0.6				C_2ClF_3								
119	1.2												
131	2.0				C_3F_5								
132	0.4												
135	2.6				C_2ClF_4	$Cl_{35}\ Cl_{37}$							
137	0.8				C_2ClF_4								
147	1.8				C_3ClF_4	$Cl_{35}\ Cl_{37}$							
149	0.6				C_3ClF_4								
151	0.7				$C_2Cl_2F_3$	$Cl_{35}\ Cl_{37}$							
153	0.6				$C_2Cl_2F_3$								
185	0.8				C_3ClF_6	$Cl_{35}\ Cl_{37}$							
187	0.2				C_3ClF_6								

D - Ionic Species Corresponding to Mass Spectral Lines

Table LXVII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE FLUID NO. 200

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F,G,H I,J
14	8.5					0.9	7.6
15	12.2		1.7	3.0	1.3	1.5	
16	340.0						340.0
17	1695.0					0.2	1694.8
18	5800.0						5800.0
19	10.3					0.4	
20	12.0						
21							
22	19.0						
23							
24							
25							
26	6.9			1.6	2.0	1.3	
27	28.5		3.1	10.7	5.0	3.1	
28	188.4		0.9	0.8		0.9	185.8
29	15.0		0.7			3.4	
30	2.0					0.8	
31	12.5					12.5	
32	10.5					0.2	10.3
33							
34							
35							
36							
37	4.7			0.9	2.3		
38	9.4			3.1	4.8		
39	41.9			18.0	18.6		
40	10.9			2.0	2.1		6.8
41	12.9			2.6	2.0	0.1	
42	6.9					0.4	
43	23.0		1.1		1.7	1.1	
44	1104.0				1.0	0.2	1102.8
45	35.0		6.2		4.9	4.5	
46	8.5				3.5	1.9	
47	4.2		3.2				
48							
49							
50	15.3			6.9	6.0		
51	28.0			17.0	9.6		
52	10.0			7.9	2.4		
53	6.8			4.4	1.2		
54							
55	8.0						
56	6.5						
57	8.0						
58							
59	3.2	0.6	0.7				
60							
61	5.0		0.7	0.7	2.0		

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D
62	7.8			2.6	4.1
63	15.5			7.1	8.8
64	3.3			1.6	2.1
65	21.5			8.7	12.9
66	4.0			1.2	1.6
67					
68					
69	3.0				
70	4.0				
71	4.0				
72					
73	6.0	5.8			
74	5.1	1.4			1.1
75	28.5	0.8	25.3	1.7	0.7
76	4.5		1.6	1.2	0.4
77	18.0		0.9	14.7	1.2
78	11.3			8.7	
79	8.8			8.2	
80					
81					
82					
83	4.0				
84					
85	3.1				0.6
86					
87					
88					
89	6.9			2.3	4.0
90	6.8			0.9	3.4
91	211.5			111.3	100.2
92	61.0			8.3	69.0
93	4.8				5.5
103	7.2			6.3	
104	3.0	0.2		3.3	
105	28.0			26.8	
106	59.0			59.0	
107	4.0			5.6	
133	4.5	1.1			
147	7.5	1.7			
149	4.0				
191	3.0	0.7			
207	35.0	2.0			
208	7.5	0.4			
209	4.5	0.2			
281	6.0	6.0			

A - Silicone Oil (See Text, Results & Discussion)
B - Trimethyl Silanol (MRC Spectra)
C - Xylene (CEC Card No. 220)
D - Toluene (CEC Card No. 214)
E - Ethanol (CEC Card No. 312)

F - Water
G - Nitrogen
H - Oxygen
I - Carbon Dioxide
J - Argon

} Atmospheric Contamination

Table LXVIII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE FLUID F-50

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F,G,H I,J
14	13.0		8.0			0.2	4.8
15	45.7		36.7			0.4	
16	332.0		2.4				329.6
17	807.0		1.1				805.9
18	2754.0						2754.0
19	5.0						
20	6.0						
21							
22	37.1						37.1
23							
24							
25	1.9		0.5				
26	10.4		3.5			0.4	
27	25.3		7.6	0.5	0.3	0.8	
28	310.0		19.7			0.2	290.1
29	34.7		14.2			0.9	
30	8.2		2.8			0.2	
31	8.5		5.1			3.4	
32	10.3						10.3
33							
34							
35							
36							
37	1.7						
38	2.7				0.3		
39	11.0		1.1	0.8	1.1		
40	5.0		0.7				4.3
41	21.9		3.5				
42	17.9		7.5			0.1	
43	55.8		23.8			0.3	
44	2241.0		5.2				2235.8
45	171.0		130.8		0.3	1.2	
46	20.2		10.1			0.5	
47	70.9		67.2				
48	3.5		3.4				
49	3.2		2.2	2.6			
50	2.8			0.3	0.3		
51	3.8			0.7	0.5		
52	4.9			0.3			
53	4.9		3.3				
54							
55	6.5		0.8				
56	14.0		1.6				
57	20.4		2.9				
58	4.7		1.5				
59	22.2	X	15.5				
60	9.0		8.2				
61	16.0		14.2				

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F,G,H I,J
62	1.6		1.1				
63	2.0		0.5	0.3	0.5		
64							
65	1.8			0.4	0.7		
66	9.8						
67	2.0						
68							
69	1.5						
70	2.5		0.7				
71	3.6		0.7				
72	4.0		2.2				
73	34.0	X	7.3				
74	7.5	X	5.2				
75	535.0	X	535.0				
76	38.2		34.5				
77	22.5		19.5	0.6			
78	3.7		0.5				
79							
80							
81							
82							
83							
84							
85	3.2						
86							
87	1.5						
88							
89	1.0				0.2		
90	2.8				0.2		
91	10.4			4.7	5.7		
92	5.2			0.4	3.9		
103	1.6			0.3			
105	1.8			1.1			
106	2.5			2.5			
129	2.8						
131	3.9						
132	2.9						
133	4.2						
147	65.3	X					
148	10.6						
149	9.8						
150	1.0						
207	4.7	X					
221	3.7	X					
281	9.0	X					
282	2.7	X					
283	1.8	X					

A - Silicone Oil Types A & C (See text, Results & Discussion)
B - Trimethyl Silanol (MRC Spectra)
C - Xylene (CEC Card No. 220)
D - Toluene (CEC Card No. 214)
E - Ethanol (CEC Card No. 312)

F - Water
G - Nitrogen
H - Oxygen
I - Carbon Dioxide
J - Argon
} Atmospheric Contamination

Table LXIX

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE GREASE G-300

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F,G,H, I,J
14	93.0		0.5	50.0	2.8	23.7	6.0
15	375.0			228.8	2.4	38.5	
16	1719.0		0.1	15.0	0.4	2.4	1701.1
17	5790.0			7.0	1.1	4.0	5777.9
18	19,660		0.4		2.4	3.1	19,654
19	74.0				1.5	10.3	
20	42.1						
21							
22	154.5						154.5
23							
24	64.0		63.1	0.7		1.8	
25	216.6		196.7	3.3	1.3	8.4	
26	78.9		4.9	22.0	8.3	34.0	
27	189.3		0.4	47.4	25.7	80.9	
28	1242.0		1.8	123.1	8.7	22.7	1085.7
29	264.6			88.4	23.8	87.8	
30	54.0		1.6	17.3	3.3	20.0	
31	496.0		0.5	31.7	138.3	325.5	
32	16.9		0.4		3.1	4.0	9.4
33	2.0			1.0	1.5		
34							
35	203.1		219.9	0.3			
36	27.4		21.6	1.3			
37	68.9		68.2	1.7	1.6		
38	17.7		7.1	2.3	2.3		
39	31.0			7.0	7.2		
40	23.1			4.3	1.4		17.4
41	44.0		0.7	22.0	9.1	3.5	
42	80.4		0.4	47.0	11.1	11.3	
43	313.0			148.1	5.1	28.0	
44	9120.0			32.4	1.0	5.5	9081.1
45	1200.0			815.4	6.1	117.3	
46	168.9			63.0		50.6	
47	604.0		139.6	418.9			
48	63.0		43.0	21.0			
49	64.2		45.7	14.0			
50	28.0		13.6	1.0			
51	16.8		0.4	1.0			
52	15.9			2.7			
53	28.9			20.7			
54	6.7			5.0			
55	22.6			16.0			
56	16.3			10.0			
57	32.8			18.3	2.0		
58	33.6			9.3	0.5		
59	220.8	39.2	71.4	96.7	13.5		
60	449.0		399.1	51.4	9.1		
61	164.4		31.9	88.7			

Mass No.	Spectrum of Mixture	Calculated Components A	B	C		
62	138.0		127.8	7.0		
63	13.6		2.8	3.3		
64	2.0			0.3		
65	27.2		16.7	1.7		
66	45.2		16.1	1.7		
67	42.0		5.2	1.3		
68	5.0		0.8	1.0		
69	8.2		0.4	2.3		
70	10.0		6.1	4.7		
71	7.1		3.7	4.7		
72	22.7			13.7		
73	216.3	376.3	0.4	45.4		
74	52.7	94.1	0.6	32.4		
75	3390.0	54.9		3335.1		
76	240.0			214.8		
77	132.0			121.4		
78	6.5			3.3		
79	2.8			1.0		
80						
81	3.7			0.7		
82	20.6		20.1	0.7		
83	11.1		9.3	2.3		
84	15.1		13.1	2.0		
85	69.4		6.0	0.7		
86	6.5		2.3			
87	29.0		1.1			
88	4.0					
89	15.5					
90	16.5					
91	68.2					
92	46.0					
93	4.0					
94	64.0		68.6			
95	707.0		707.0			
96	70.6	27.4	59.7			
97	452.0		455.0			
98	17.0		17.0			
99	73.8		73.2			
100	6.0		2.3			
101	10.0		0.8			
102	1.5		0.1			
103	81.3					
104	11.5					
105	12.8					
106	5.0					
107	1.8					
108	1.0					
109	1.2					

A - Silicone Oil (See Text, Results & Discussion)
B - Trichloroethylene (MRC Spectra)
C - Trimethyl Silanol (MRC Spectra)
D - 1-Propanol (CEC Card No. 325)
E - Ethanol (CEC Card No. 312)

F - Water
G - Nitrogen
H - Oxygen
I - Carbon Dioxide
J - Argon
} Atmospheric Contamination

Table LXIX - Cont'd

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B										
119	15.2												
125	12.1	19.6											
130	620.0		701.8										
131	22.1		18.2										
132	589.0		672.6										
133	142.5	70.6	15.8										
134	198.0		215.0										
135	43.8		6.4										
136	22.0		22.8										
137	10.8		0.7										
147	161.1	113.7											
148	27.7												
149	181.2												
150	26.4												
151	15.9												
177	15.0												
191	31.0	43.0											
193	24.0	47.0											
207	116.4	129.4											
249	16.2	23.5											
251	11.1	25.5											
265	22.3	27.4											
267	26.7	113.7											
281	392.0	392.0											
282	111.6	109.8											
283	68.5	70.6											

A - Silicone Oil (See Text, Results & Discussion)
B - Trichloroethylene (MRC Spectra)

Table LXX

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE RELEASE AGENT DC-7

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C	D, E, F, G, H				A	B	C	D, E, F, G, H	
14	46.8	20.6	3.9		22.3		62						
15	50.6	33.5	9.5				63						
16	213.0	2.1	1.4		209.5		64						
17	1020.0	3.5			1016.5		65						
18	3240.0	2.7			3237.3		66						
19	13.5	9.0					67						
20	8.4				8.4		68						
21							69						
22	8.6				8.6		70						
23							71						
24	1.5		0.4				72						
25	7.4	1.6	1.2				73	3.6			25.8		
26	30.2	7.3	2.2				74	0.7			6.5		
27	70.9	70.4	1.1				75	5.2			3.8		
28	202.5	19.7	0.9		181.9		76						
29	89.0	76.5	22.5				77						
30	18.6	17.5	0.3				78						
31	283.5	283.5					79						
32	43.9	3.5			40.4		80						
33							81						
34							82						
35							83						
36	1.6						84						
37							85						
38	1.0						86						
39	2.0						87						
40	8.1		0.2		7.9		88						
41	6.2	3.0	0.9				89						
42	13.7	9.9	2.1				90						
43	36.8	24.4	6.0				91						
44	505.0	4.8	10.1		490.1								
45	110.1	102.1	0.3										
46	40.1	44.1					96	8.0			1.9		
47	2.0						119	1.5					
48							125	0.6			1.3		
49							133	6.0			4.8		
50							147	2.5			7.8		
51							177	2.4					
52							191	4.8			3.0		
53							193	2.6			3.2		
54							207	43.5			8.9		
55							208	9.2			1.9		
56							209	5.6			1.1		
57							249	1.0			1.6		
58							265	1.4			1.9		
59	1.4			2.7			281	26.9			26.9		
60							282	7.2			7.5		
61							283	4.3			4.8		

A - Ethanol (CEC Card No. 312)
B - Acetaldehyde (CEC Card No. 308)
C - Silicone Oil (See Text, Results & Discussion)
D - Water
E - Nitrogen
F - Oxygen } Atmospheric Contamination
G - Carbon Dioxide
H - Argon

Table LXXI

REPRESENTATIVE MASS SPECTRAL DATA FOR DC-4 (MIL-I-8660)

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G,H,I
14	27.7	12.5				15.2
15	28.2	20.3				
16	237.0	1.3				235.7
17	1437.0	2.1				1434.9
18	5000.0	1.6				4998.4
19	14.0	5.4				
20	12.8					12.8
21						
22	6.5					
23						
24	1.6	1.0				
25	5.0	4.4				
26	20.6	17.9				
27	45.7	42.6				
28	51.8	11.9				39.9
29	57.1	46.3				
30	12.1	10.6				
31	171.6	171.6				
32	48.6	2.1				46.5
33						
34						
35						
36	2.7					
37	1.3					
38	2.3					
39	4.2					
40	8.6					8.6
41	3.8	1.8				
42	7.9	6.0				
43	21.8	14.8			C_3H_7	
44	372.0	2.9				369.1
45	70.4	61.8	1.3			
46	25.4	26.7				
47	2.0		0.7			
48						
49						
50	4.3					
51	4.8					
52	4.7					
53						
54						
55	0.7					
56	0.4					
57	0.5				C_4H_9	
58	0.9				C_4H_{10}	
59	1.3			2.2		
60						
61	1.5					

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G,H,I
62						
63	1.1					
64						
65						
66	0.8					
67						
68						
69						
70						
71						
72						
73	3.1			21.0		
74	1.6			5.3		
75	8.5		5.4	3.1		
76	2.0					
77	3.6					
78	5.0					
79	1.6					
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
96	4.7			1.5		
119	1.0					
125	0.7			1.1		
133	4.1			3.9		
147	3.3			6.4		
177	1.4					
191	3.2			2.4		
193	2.0			2.6		
207	25.2			7.2		
208	5.4			1.5		
209	3.2			0.9		
249	1.0			1.3		
265	1.2			1.5		
281	21.9			21.9		
282	5.7			3.5		
283	3.8			2.6		

A - Ethanol (CEC Card No. 312)
B - Trimethyl Silanol (MRC Spectra)
C - Silicone Oil (See Text, Results & Discussion)
D - C_{4-5} Hydrocarbons

E - Water)
F - Nitrogen)
G - Oxygen) Atmospheric
H - Carbon Dioxide) Contamination
I - Argon)

Table LXXII

REPRESENTATIVE MASS SPECTRAL DATA
FOR WAX LUBRICANT NO. 111

Mass No.	Spectrum of Mixture	Calculated Components A	B, C, D, E,		
14	6.2				
15	4.8				
16	289		289		
17	2025		2026		
18	7180		7180		
19	13				
20	15.6				
21					
22	2.4				
23					
24					
25					
26	1.6				
27	26.3	C_2H_3			
28	66	C_2H_4	66		
29	30.2	C_2H_5			
30					
31					
32	20		20		
33					
34					
35					
36					
37					
38					
39	15.3				
40	6.4		6.4		
41	42.5	C_3H_5			
42	11.7	C_3H_6			
43	68.9	C_3H_7			
44	137.7		137		
45	2.2				
46					
47	7.9				
48	3.3				
49	2.8				
50	2.0				
51					
52					
53	3.9				
54	1.9				
55	22.6	C_4H_7			
56	20.0	C_4H_8			
57	72.7	C_4H_9			
58	3.8				
59					
60					
61					

Mass No.	Spectrum of Mixture	Calculated Components A				
62						
63	0.5					
64						
65	1.0					
66						
67	3.0					
68	2.0					
69	12.8	C_5H_9				
70	11.8	C_5H_{10}				
71	28.7	C_5H_{11}				
72	2.0					
73						
74						
75						
76						
77	1.5					
78						
79						
80						
81	3.0					
82	2.9					
83	25.5	C_6H_{13}				
84	6.5					
85	26.1	C_6H_{13}				
86	1.3					
87	2.5					
88						
89						
90						
91						
92						
93						
94						
95	2.6					
96	2.0					
97	5.0	C_7H_{13}				
98	5.5	C_7H_{14}				
99	4.5	C_7H_{15}				
100	0.8					
101	2.0					
102						
103						
104						
105						
106						
107						
108						
109						

A - Petroleum Ether
B - Carbon Dioxide)
C - Argon) Atmospheric
D - Oxygen) Contaminants
E - Nitrogen)

Table LXXIII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILASTIC RTV 882

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E, F,G.	
14	105.3	62.5			42.8	
15	268.8	55.0			213.8	
16	825.0	9.1			815.9	
17	478.0	23.9			454.1	
18	1617.0	54.0			1563.0	
19	38.2	33.9				
20						
21						
22	123.0				123.0	
23						
24						
25	40.3	28.9				
26	235.5	189.0				
27	724.0	583.4				
28	1107.0	198.1			908.9	
29	858.0	539.8				
30	87.6	75.7				
31	3140.0	3140.0				
32	90.4	70.3			20.1	
33	33.1	33.6				
34						
35						
36						
37	41.2	36.4				
38	59.0	51.8				
39	195.9	163.9	2.6			
40	44.0	32.0				
41	270.0	206.9				
42	288.0	252.8				
43	247.8	116.5				
44	7600.0	23.2			7576.8	
45	269.0	138.2			130.8	
46	34.3				34.3	
47						
48						
49						
50						
51						
52						
53	11.7					
54						
55	21.4					
56						
57	68.2	46.2				
58	66.2	10.4				
59	317.0	306.5				
60	174.0	206.0				
61	10.2					

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E, F,G	
72	26.4					
73	24.8			24.8		
91	14.7		14.7			
92	8.9		10.1			
96	27.0			27.0		
133	24.3			24.3		
191	18.7			18.7		
207	152.4			152.4		
208	32.4			32.4		
209	18.8			18.8		
281	131.7			131.7		
282	35.9			35.9		
283	22.3			22.3		

A - 1-Propanol (CEC Card No. 325)
B - Toluene (CEC Card No. 214)
C - Silicone Oil (See text)

D - Water)
E - Nitrogen) Atmospheric
F - Oxygen) Contamination
G - Carbon Dioxide)

Table LXXIV

REPRESENTATIVE MASS SPECTRAL DATA
FOR SILASTIC RTV 731

Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G			Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G		
14	84.6	81.0		3.6			62						
15	189.0	207.5	0.5				63						
16	175.5	29.0		146.5			64						
17	1134.0	19.5		1114.5			65						
18	2860.0	30.0		3860.0			66						
19	7.5	0.5					67						
20	10.0						68						
21							69						
22							70						
23							71						
24	3.1	2.5					72						
25	7.2	6.2					73						
26	7.3	5.4					74						
27	9.4	1.4					75	8.0		8.0			
28	97.2	20.8		76.4			76						
29	74.8	61.0					77						
30	5.3	2.9					78						
31	24.3	18.4					79						
32	25.0	0.4		24.6			80						
33							81						
34							82						
35							83						
36	4.5	0.3					84						
37							85						
38							86						
39	5.0	0.3					87						
40	9.3	5.1		4.2			88						
41	25.0	17.8					89						
42	63.5	57.7					90						
43	370.0	370.0					91						
44	34.5	18.2		16.3			92						
45	365.0	334.0	2.0				93						
46	5.0	4.0					94						
47	3.0	1.4	1.0				95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60	174.9	190.9					108						
61	4.6	4.3					109						

A - Acetic Acid (API Serial No. 1451)
B - Trimethyl Silanol (MRC Spectra)
C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric
F - Carbon Dioxide) Contamination
G - Argon)

Table LXXV

REPRESENTATIVE MASS SPECTRAL DATA FOR SEALANT RTV 90

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E		Mass No.	Spectrum of Mixture	Calculated Components A	B	C		
14	745	742					62						
15	1215	1206					63	1.0					
16	156	74			83		64						
17	698	123			586		65						
18	2080	94			1990		66						
19	340	323					67	1.0					
20	7.0						68	1.0					
21	3.0						69	2.2		C_5H_9			
22	3.0				2.3		70	2.0		C_5H_{10}			
23							71	3.0		C_5H_{11}			
24	50.0	57					72						
25	255	263					73	11.0			13		
26	1044	1065					74						
27	2550	2533					75						
28	710	710			13		76						
29	2721	2750					77						
30	638	631					78						
31	10,000	10,058					79						
32	129	125					80						
33	24						81						
34							82						
35							83						
36							84						
37							85						
38							86						
39	3.0						87						
40	33.0						88						
41	112.5	109					89						
42	355.	355					90						
43	887	877					91						
44	298	171			127		92						
45	3800	3675			1.5		93						
46	1455	1585					94						
47	52.8						95						
48	4.2						96						
49	2.5						97						
50	1.0						98						
51	2.0						99						
52	2.0						100						
53	1.0												
54													
55	3.5												
56	2.6		C_4H_8										
57	6.0		C_4H_9										
58							281	13.8			13.8		
59							282	4.0			3.5		
60							283	2.5			2.5		
61													

A - Ethanol (CEC Card No. 312)
B - C_{5-6} Hydrocarbon
C - Silicone Oil (See Text, Results & Discussion)
D - Water)
E - Carbon Dioxide) Atmospheric Contaminants

Table LXXVI

REPRESENTATIVE MASS SPECTRAL DATA FOR SILASTIC RTV 501

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C	D,E,F,G,H								
14	240	198.7			41.3		62						
15	177	174.7					63						
16	55.5	29.0			26.5		64						
17	211.5	75.9			135.6		65						
18	640	171.7			468.3		66						
19	119.1	107.8					67						
20	10.3						68						
21							69						
22							70						
23							71						
24	17.2						72						
25	100	91.9	0.1	0.7			73						
26	679	601.1	1.4	2.7			74						
27	2112	1855.0	10.9	3.7			75						
28	850	630.1	3.6	0.8	215.5		76						
29	1944	1716.0	6.6	2.0			77						
30	282	240.6	0.5				78						
31	>10,000	9985.0	21.6				79						
32	300	223.7	0.4		75.9		80						
33	129.9	106.8	1.7				81						
34							82						
35							83						
36	21.0						84						
37	129.9	115.8	0.3	1.0			85						
38	186.6	164.8	0.6	1.1			86						
39	590	521.2	3.4	1.8			87						
40	123.0	101.8	0.8	0.4	20.0		88						
41	765	658.0	13.3	1.0			89						
42	984.0	803.8	6.8	3.3			90						
43	430	370.4	13.0	46.6			91						
44	98.4	73.9	0.9	1.0	22.6		92						
45	227.4	439.3	1.4				93						
46							94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53	28.5		0.2				101						
54	4.5		0.2				102						
55	41.3		2.5				103						
56	17.4		17.4				104						
57	146	146.8	1.2	0.4			105						
58	44.6	33.0		12.6			106						
59	1185	974.5		0.4			107						
60	655	655.0					108						
61	26.3						109						

A - 1-Propanol (CEC Card No. 325)
B - 1-Butanol (CEC Card No. 346)
C - Acetone (CEC Card No. 318)

D - Water)
E - Nitrogen) Atmospheric
F - Oxygen) Contamination
G - Carbon Dioxide)
H - Argon)

Table LXXVII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILASTIC C/R Q-3-0121

Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G			Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G		
14	266.1	208.3		57.8			62	2.8	2.3				
15	591.0	533.5	0.7	56.8			63						
16	204.9	74.7		130.2			64						
17	705.0	50.0		655.0			65						
18	2304.0	77.2		2226.8			66						
19	7.0	1.3					67						
20	13.6			13.6			68						
21							69						
22	5.8			5.8			70						
23							71						
24	10.6	6.5					72						
25	22,8	15.9					73						
26	21.3	14.0					74						
27	17.3	3.6					75	9.8		9.8			
28	291.0	53.5		237.5			76						
29	216.0	157.0					77						
30	11.0	7.4					78						
31	22.8	47.4					79						
32	48.0			48.0			80						
33							81						
34							82						
35							83						
36							84						
37							85						
38							86						
39							87						
40	24.0	13.0		11.0			88						
41	62.0	45.7					89						
42	180.0	148.0					90						
43	951,0	951.0					91						
44	340.0	46.7		293.3			92						
45	810.0	859.0	2.4				93						
46	16.0	10.4					94						
47	6.5	3.6	1.2				95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60	519.0	491.0					108						
61	13.0	11.0					109						

A - Acetic Acid (API Serial No. 1451)
B - Trimethyl Silanol (MRC Spectra)
C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric
F - Carbon Dioxide) Contamination
G - Argon)

Table LXXVIII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE EC 1663

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C	D,E,F, G,H				A	B	C	D,E,F, G,H,	
14	81.5			80.0	1.5		62	2.0					
15	129.9		0.2	126.6			63	5.0	3.3				
16	542.0			7.8	534.2		64						
17	867.0				853.9		65	5.2	4.0				
18	2904.0			10.1	2893.9		66						
19	37.5			34.0			67						
20	7.0						68						
21							69						
22	70.5				70.5		70						
23							71						
24	5.2			6.0			72						
25	26.5			27.6			73	3.3					
26	110.1			111.9			74	2.5					
27	271.2	4.9		266.0			75	2.3		2.3			
28	542.0			74.5	467.5		76	0.8		0.1			
29	293.0			289.0			77	4.8	6.7				
30	66.9			66.3			78	3.5	4.0				
31	1071.0			1071.0			79	2.0	3.8				
32	21.0			13.2	7.8		80						
33	2.0						81						
34							82						
35							83						
36							84						
37							85						
38	2.0						86						
39	12.1	8.3					87						
40	10.5				10.5		88						
41	15.4			11.5			89						
42	38.2			37.3			90						
43	100.5			92.1			91	51.0	51.0				
44	4050.0			18.0	4032.0		92	16.3	3.8				
45	444.0		0.6	385.9			93						
46	168.0			166.6			94						
47	5.3		0.3				95						
48							96						
49							97						
50	4.0	3.2					98						
51	7.3	7.8					99						
52	2.2	3.6					100						
53	2.0	2.0					101						
54							102						
55	2.0						103	2.0	2.9				
56							104	1.0	1.5				
57	1.8						105	7.3	12.2				
58							106	16.3	27.0				
59							107						
60							108						
61	2.0						109						

A - Xylene (CEC Card No. 220)
B - Trimethyl Silanol (MRC Spectra)
C - Ethanol (CEC Card No. 312)

D - Water)
E - Nitrogen)
F - Oxygen) Atmospheric
G - Carbon Dioxide) Contamination
H - Argon)

Table LXXIX

REPRESENTATIVE MASS SPECTRAL DATA FOR SEALER - EPON 828

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C, D, E, F, G					A	B	C, D, E, F, G		
14	47.3		0.7	46.6			62	1.0	1.0				
15	261.0		1.2				63	1.0	1.6				
16	845.0			845.0			64						
17	1599.0		0.1	1598.9			65	1.0	1.6				
18	5010.0	1.6		5008.4			66						
19	11.0	0.6	0.3				67	17.9	15.5				
20	12.4						68	1.0	1.1				
21							69	7.6	6.7				
22	105.0			105.0			70	1.0	0.6				
23							71	2.0	2.4				
24							72	6.0	4.7				
25	2.4	1.4					73						
26	33.1	24.9	1.1				74						
27	221.7	190.1	2.5				75	1.0					
28	748.0	27.7	0.7	719.6			76						
29	234.3	211.5	2.7	20.1			77						
30	11.4	6.3	0.6				78						
31	16.5	6.4	10.1				79						
32	11.1	0.9	0.1	10.1			80						
33							81						
34							82						
35							83	1.0					
36							84						
37	12.2	10.0					85	142.5	142.5				
38	27.3	21.6					86						
39	203.4	170.2					87						
40	37.2	24.6		12.6			88						
41	309.0	272.6	0.1				89						
42	101.5	88.3	0.4				90						
43	1494.0	1422.2	0.9				91						
44	5940.0	35.0	0.2	5904.8			92						
45	89.4	10.1	3.6	75.7			93						
46	24.7		1.6				94						
47							95						
48							96						
49							97						
50	9.9	7.9					98						
51	10.5	8.8					99						
52	3.5	2.6					100	124.2	149.9				
53	11.2	10.2					101	8.7	9.2				
54	2.7	2.1					102						
55	18.0	18.3					103						
56	15.1	14.4					104						
57	279.6	271.1					105						
58	432.0	458.9					106						
59	28.8	28.7					107						
60	2.7	1.7					108						
61	1.0	0.7					109						

A - Methyl Isobutyl Ketone (API Serial No. 380)
B - Ethanol (CEC Card No. 312)
C - Water)
D - Nitrogen) Atmospheric
E - Oxygen) Contamination
F - Carbon Dioxide)
G - Argon)

Table XXC

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE PRIMER A-4004

Mass No.	Spectrum of Mixture	Calculated Components A	B	C,D,E, F,G			Mass No.	Spectrum of Mixture	Calculated Components				
14	12.8	1.8		11.0			62						
15	15.4	3.0		12.4			63						
16	211.2			211.2			64						
17	1227.0			1227.0			65						
18	3790.0			3790.0			66						
19	9.8						67						
20	9.0						68						
21							69						
22	6.0						70						
23							71						
24							72						
25							73						
26	12.0	2.6	6.9				74						
27	65.4	6.3	54.6				75						
28	123.6	1.8	17.9	103.9			76						
29	45.4	6.8	33.0				77						
30	3.8		2.5				78						
31	133.5	25.2	108.3				79						
32	19.0	1.6	1.7	15.7			80						
33	7.0		8.7				81						
34							82						
35							83						
36	2.1						84						
37	3.2		1.5				85						
38	5.0		2.8				86						
39	24.2		17.2				87						
40	9.2		4.2	5.0			88						
41	70.1		66.8				89						
42	34.8		34.0				90						
43	66.0	2.2	65.3				91						
44	411.0		4.6	406.4			92						
45	11.5	9.1	7.1				93						
46	2.5	3.9					94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55	15.0		12.6				103						
56	87.3		87.3				104						
57	12.3		6.2				105						
58							106						
59							107						
60							108						
61							109						

A - Ethanol (CEC Card No. 312)
B - 1-Butanol (CEC Card No. 346)
C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric Contamination
F - Carbon Dioxide)
G - Argon)

Table XXCI

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE PRIMER SS-4004

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E	F	G	H,I,J,K,L
14	570.0					396.5		126.9	46.6
15	1626.0			1.6		1271.1		206.0	
16	325.0					52.6		12.7	259.7
17	954.0					51.8		21.3	880.9
18	3170.0					65.8		16.4	3087.8
19	788.0					613.2		55.2	
20	21.5								
21	2.0								
22	5.0								5.0
23									
24	17.5							9.8	
25	96.0				0.1	56.1	1.7	45.0	
26	488.0			2.6	1.3	295.6	6.4	182.1	
27	2250.0	1.4	1.0	6.4	10.1	1537.7	8.9	432.9	
28	490.0				3.3	144.7	1.9	121.3	218.8
29	1704.0				6.1	1093.8	4.8	470.2	
30	186.0				0.5	93.0	0.2	107.9	
31	2109.0				20.0	512.3	0.6	1742.6	
32	69.0				0.3			21.4	47.3
33	24.7				1.6				
34									
35									
36	27.2						0.6		
37	174.0			2.9	0.3	146.5	2.3		
38	270.0			6.2	0.5	220.2	2.6		
39	818.0	2.0	1.7	23.8	3.2	631.6	4.2		
40	136.0			2.7	0.8	94.7	0.9		36.9
41	999.0			2.6	12.3	674.6	2.4	18.6	
42	602.0				6.3	422.8	7.8	60.6	
43	2250.0			2.2	12.0	1718.4	111.4	149.9	
44	1716.0			1.2	0.8	314.0	2.5	29.3	1368.2
45	>10,000			6.2	1.3	8772.0		627.9	
46	420.0			4.4	0.1	200.9		271.1	
47	30.0								
48									
49	3.0			1.2					
50	19.2		0.6	7.7	0.2				
51	24.5	1.4	1.6	12.2	0.1				
52	8.8		0.7	3.0					
53	19.0			1.5	0.2				
54	3.5				0.2				
55	40.2				2.3				
56	16.1				16.1				
57	47.5				1.1		0.9		
58	30.2						30.2		
59	300.0					300.0	1.0		
60	36.0					36.0			
61	6.0			2.6					

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E
62	9.0			5.2		
63	18.9		0.7	11.2		
64	4.5			2.7		
65	20.9	1.0	0.8	16.5		
66	3.5			2.1		
67	2.0					
68	2.0					
69	10.0					
70	3.2					
71	5.0					
72	5.2					
73	6.0				0.3	
74	3.0			1.4	0.1	
75	2.0			0.9		
76	1.8			0.6		
77	6.4	1.9	1.4	1.5		
78	2.6		0.8			
79	3.0	1.2	0.8			
80						
81						
82						
83	3.2					
84	3.0					
85	3.5			0.8		
86	2.2			1.1		
87	3.0			0.7		
88						
89	6.2			5.1		
90	4.0			4.3		
91	140.0	1.9	10.4	127.7		
92	93.0	0.5	0.8	88.0		
93	7.6			7.0		
94						
95						
96						
97	5.0					
103	1.7	0.9	0.6			
104	1.0	0.4				
105	20.8	18.1	2.5			
106	7.0	1.5	5.5			
118	1.5					
119	3.0	0.4				
120	7.0	5.4				
121	3.4	0.5				

A - C3 Alkyl Benzene (CEC Card No. 225)
B - Xylene (CEC Card No. 220)
C - Toluene (CEC Card No. 214)
D - 1-Butanol (CEC Card No. 346)
E - 2-Propanol (CEC Card No. 326)
F - Acetone (CEC Card No. 318)
G - Ethanol (CEC Card No. 312)

H - Water, I - Nitrogen, J - Oxygen, K - Carbon Dioxide, L - Argon: Atmospheric Contamination

Table XXCII

REPRESENTATIVE MASS SPECTRAL DATA FOR SILICONE PRIMER EC-1694

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G,H,I
14	71.5	55.5	7.5			8.5
15	207.0	177.9	12.1			
16	343.0	7.4	0.7			334.9
17	215.1	7.2	1.3			206.6
18	715.0	9.2	1.0			704.8
19	95.7	85.8	3.3			
20	4.0					
21						
22	13.6					13.6
23						
24	2.5		0.6			
25	11.3	7.9	2.6	0.6		
26	64.4	41.4	10.7	7.9		
27	324.0	215.5	25.5	62.8	3.4	
28	395.0	20.3	7.1	20.6		347.0
29	237.0	153.1	27.7	38.0		
30	23.3	13.0	6.4	2.9		
31	300.0	71.7	102.7	124.6		
32	12.8		1.3	2.0		9.5
33	9.8			10.1		
34						
35						
36	4.0					
37	25.0	20.5		1.7		
38	39.0	30.8		3.2	3.3	
39	131.1	88.4		19.8	12.6	
40	25.4	13.3		4.8		7.3
41	186.0	94.4	1.1	76.9		
42	105.0	59.2	3.6	39.1		
43	333.0	240.6	8.8	75.1		
44	2907.0	44.0	1.7	5.2		2856.1
45	1299.0	1228.0	37.0	8.1	3.3	22.6
46	57.0	28.1	16.0	0.6		
47						
48						
49						
50	7.0			1.0	4.1	
51	8.6			0.9	6.5	
52						
53	4.7			1.2		
54	1.5			1.2		
55	21.5			14.5		
56	100.5			100.5		
57	16.0			7.1		
58	6.0					
59	42.0	42.0				
60	4.8	5.0				
61						

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D	E,F,G,H,I
62	3.5				2.8	
63	6.9				6.0	
64						
65	9.2				8.8	
66						
67						
68						
69						
70						
71						
72						
73	2.0			1.6		
74	1.8			0.6		
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90	4.5				2.3	
91	68.0				68.0	
92	45.5				46.9	
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						
106						
107						
108						
109						

A - 2-Propanol (CEC Card No. 326)
B - Ethanol (CEC Card No. 312)
C - 1-Butanol (CEC Card No. 346)
D - Toluene (CEC Card No.214)

E - Water)
F - Nitrogen)
G - Oxygen) Atmospheric
H - Carbon Dioxide) Contamination
I - Argon)

Table XXCIII

REPRESENTATIVE MASS SPECTRAL DATA FOR ELECTRICAL RESIN, SCOTCHCAST NO. 8

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components			
		A	B	C	D	E,F,G, H,I			A	B	C	D
14	20.4			0.9		19.5	62	4.5	3.6			
15	50.3	1.1		0.8			63	9.4	7.7			
16	178.8			0.1		178.7	64	2.3	1.8			
17	709.0			0.3		708.7	65	12.4	11.3			
18	2388.0			0.8		2387.2	66	1.9	1.4			
19	4.5			0.5			67	1.2				
20	7.9						68					
21							69	0.8				
22	11.1					11.1	70					
23							71					
24							72	0.7				
25	1.4			0.4	1.8		73	1.0				
26	7.3	1.8		2.7	6.9		74	1.3	0.9			
27	20.5	4.4		8.2	9.6		75	1.6	0.6			
28	140.7			2.8	2.0	135.9	76	2.7	0.4			
29	44.5			7.6	5.1		77	1.5	1.0	0.1		
30	4.9			1.1	0.2		78	0.5				
31	43.9			44.2	0.7		79					
32	61.9			1.0		60.9	80					
33	0.6			0.5			81					
34							82					
35	0.7						83					
36	3.2				0.7		84					
37	5.0	2.0		0.5	2.5		85	8.0	0.5			
38	9.0	4.2		0.7	2.8		86	1.5	0.8			
39	29.5	16.3	0.1	2.3	4.6		87	0.8	0.5			
40	6.4	1.8		0.5	1.0	3.1	88					
41	18.9	1.8		2.9	2.5		89	3.8	3.5			
42	9.4			3.6	8.4		90	4.1	3.0			
43	122.7	1.5		1.6	119.6		91	87.5	87.5			
44	576.0	0.8		0.3	2.7	572.2	92	64.0	60.2			
45	16.1	4.3		1.9			93	4.5	4.8			
46	5.6	3.0					94					
47							95					
48							96					
49	1.1	0.8					97					
50	7.3	5.3	0.1				98					
51	10.2	8.4	0.1				99					
52	2.7	2.1	0.1				100					
53	2.0	1.0					101					
54							102					
55	1.6						103					
56	1.2						104					
57	14.5			0.6	1.0		105					
58	31.4			0.1	32.4		106					
59	2.0			4.3	1.1		107					
60	2.9			2.9			108					
61	2.6	1.8					109					

A - Toluene (CEC Card No. 214)
B - Benzene (CEC Card No. 212)
C - 1-Propanol (CEC Card No. 325)
D - Acetone (CEC Card No. 318)

E - Water)
F - Nitrogen)
G - Oxygen) Atmospheric
H - Carbon Dioxide) Contamination
I - Argon)

Table XXCIV

REPRESENTATIVE MASS SPECTRAL DATA FOR DC-325

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D,E, F,G,H	
14	129.3				129.3	
15	20.5		0.2			
16	234.3				234.3	
17	1164.0				1164.0	
18	4010.0				4010.0	
19	8.0					
20	25.6				25.6	
21						
22	10.3				10.3	
23						
24						
25						
26	4.2	2.9				
27	9.0	4.1				
28	318.0				318.0	
29	10.9	2.2			8.7	
30						
31	4.8					
32	33.2				33.2	
33						
34						
35	2.8					
36	12.6					
37	2.1	1.1				
38	5.6	1.2				
39	4.2	1.9		0.6		
40	6.7				6.7	
41	5.6	1.1				
42	5.5	3.6				
43	50.9	50.9				
44	539.0				539.0	
45	9.5		0.7		8.8	
46	2.9				2.9	
47	1.0		0.4			
48						
49						
50						
51						
52						
53						
54						
55	1.6					
56	2.8					
57	3.7					
58	10.6	13.8				
59						
60						
61						

Mass No.	Spectrum of Mixture	Calculated Components A	B	C	D.E, F,G,H	
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75	2.8		2.8			
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91	2.0			2.0		
92	1.3			1.4		
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						
106						
107						
108						
109						

A - Acetone (CEC Card No. 318)
B - Trimethyl Silanol (MRC Spectra)
C - Toluene (CEC Card No. 214)

D - Water)
E - Nitrogen) Atmospheric
F - Oxygen) Contamination
G - Carbon Dioxide)
H - Argon)

Table XXCV

REPRESENTATIVE MASS SPECTRAL DATA
FOR PLEXIGLAS, NO. 2 CLEARMIL

Methylmethacrylate is present as a low level gas-off product. The following lines were observed and are the strong lines of methyl methacrylate according to API spectrum No. 1648.

Mass	Intensity Chart Div.
41	31
69	20
39	12.3
100	10.4
40	3.1
59	2.5

Table XXCVI

REPRESENTATIVE MASS SPECTRAL DATA
FOR THERMOFIT TUBING SPLICER C/R 197-075

A trace of hydrocarbon was detected as a gas-off product. These are characterized by weak lines at the following masses:

Mass	Species
27	C_2H_3
29	C_2H_5
43	C_3H_7
57	C_4H_9

Table XXCVII

REPRESENTATIVE MASS SPECTRAL DATA FOR ACETAL RESIN, DELRIN NO. 100

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B	C,D,E, F,G									
14	74.7			72.8			62						
15							63						
16	169.			156			64						
17	847			850			65						
18	2980			2980			66						
19	4.5						67						
20	8.0			1.5			68						
21							69						
22	5.0			5.1			70						
23							71						
24							72						
25							73						
26	2.0		1.3				74						
27	6.0		1.0				75						
28	576	57		487			76						
29	245.4	185	24.0				77						
30	164.4	164					78						
31	8.0	3.5					79						
32	107.1			107			80						
33							81						
34							82						
35							83						
36							84						
37							85						
38							86						
39	3.5						87						
40	12.0		1.9	12.0			88						
41	6.0		1.5				89						
42	2.0		3.5				90						
43	11.8		11.8				91						
44	302		21.2	280			92						
45	5.9		1.0	3.2			93						
46	1.5			1.2			94						
47							95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60							108						
61							109						

A - Formaldehyde (API Serial No. 84)
B - Acetaldehyde (API Serial No. 293)
C - Water)
D - Nitrogen)
E - Oxygen) Atmospheric Contamination
F - Carbon Dioxide)
G - Argon)

Table XXCVIII

MASS SPECTRAL DATA FOR GLC FRACTION OF COMPONENT COMMON TO GAS-OFF PRODUCTS FROM MAGNESIUM/LITHIUM ALLOYS, LA-91, LA-141, AND LA-2-933

Mass No.	Spectrum of Mixture	Calculated Components					Mass No.	Spectrum of Mixture	Calculated Components				
		A	B, C, D, E										
14	40.3						62						
15	25.3						63						
16	681		681				64						
17	2312		2312				65						
18	>10,000		16,210				66						
19	52.1						67						
20							68						
21							69						
22							70						
23							71						
24							72						
25	1.3						73						
26	6.1						74						
27	31.7	X					75						
28	383.2		383				76						
29	30.6	X					77						
30	4.5						78						
31	18.0						79						
32	68.2		68				80						
33							81						
34							82						
35							83						
36	3.0						84						
37	2.0						85						
38	3.4						86						
39	9.0						87						
40	10.9						88						
41	12.0	X					89						
42	9.1						90						
43	50.1	X					91						
44	295		295				92						
45	81.2	X					93						
46	4.0						94						
47	2.1						95						
48							96						
49							97						
50							98						
51							99						
52							100						
53							101						
54							102						
55							103						
56							104						
57							105						
58							106						
59							107						
60							108						
61							109						

A - Possibly a C_5 or higher secondary alcohol (Characteristic Lines Marked by "X")
B - Water
C - Carbon Dioxide
D - Nitrogen
E - Oxygen

(B–E) Atmospheric Contaminants

APPENDIX III

REPRESENTATIVE GAS CHROMATOGRAMS

FOR

GAS-OFF EXPERIMENTS

The gas chromatograms shown in this appendix were obtained on an F & M Scientific Corporation Model 810 Gas Chromatograph. Instrument conditions and column specifications are listed in Table XXCIX. Since retention times tended to shift somewhat due to column aging, a standard mixture was used as a day to day reference.

The gas chromatograms are representative of a particular candidate material. In comparing patterns for different candidate materials, consideration must be taken of instrument sensitivity factors and the amounts of atmosphere used for analysis. Although, generally a 25 ml aliquot was used, some of the early analyses were performed on the condensate from the total 9-liter volume.

Table XXCIX

GAS CHROMATOGRAPHIC INSTRUMENT CONDITIONS

Detector (All samples in Section I were analyzed using a flame ionization detector and a F & M Model 810 Research Gas Chromatograph)

Condition

D
Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Dual column detection Flow split - 1:10
Column A Flow Rate - 60 ml/min.
Column B Flow Rate - 130 ml/min.
Range - 10 Attenuation - X4

E
Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Dual column detection
Column A Flow Rate - 60 ml/min.
Column B Flow Rate - 130 ml/min.
Range - 10 Attenuation - X8

F
Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Dual column detection
Column A Flow Rate - 60 ml/min.
Column B Flow Rate - 130 ml/min.
Range - 10^2 Attenuation - X8

G
Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 60 ml/min.
Range - 10^2 Attenuation - X16

H
Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 60 ml/min.
Range - 10 Attenuation - X16

Table XXCIX - Cont'd

Condition

I Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 60 ml/min.
Range - 10 Attenuation - X16

J Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 20 ml/min.
Range - 10 Attenuation - X32

K Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection Flow split - 1:10
Column A Flow Rate - 85 ml/min.
Range - 10 Attenuation - X16

L Column temp. - 35°-240°C @ 10°C/min.
Detector t-mp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 60 ml/min.
Range - 10 Attenuation - X8

M Column temp. - 35°-240°C @ 10°C/min.
Detector temp. - 275°C Injection port temp. - 260°C
Single column detection
Column A Flow Rate - 40 ml/min.
Range - 10 Attenuation - X8

Columns used with the above instrument conditions.

1 5% Carbowax 20 m on 60-80 mesh Gas-Pack F 11' x 1/4" stainless steel tubing. Packed 9-64.

2 Same as Column No. 1 only repacked with new substrate on 4-2-65.

3 Repacked with a new lot of substrate, same as Column No. 1. But due to the inadequacy to separate the components in the standard, it was repacked with the old substrate from Column No. 2.

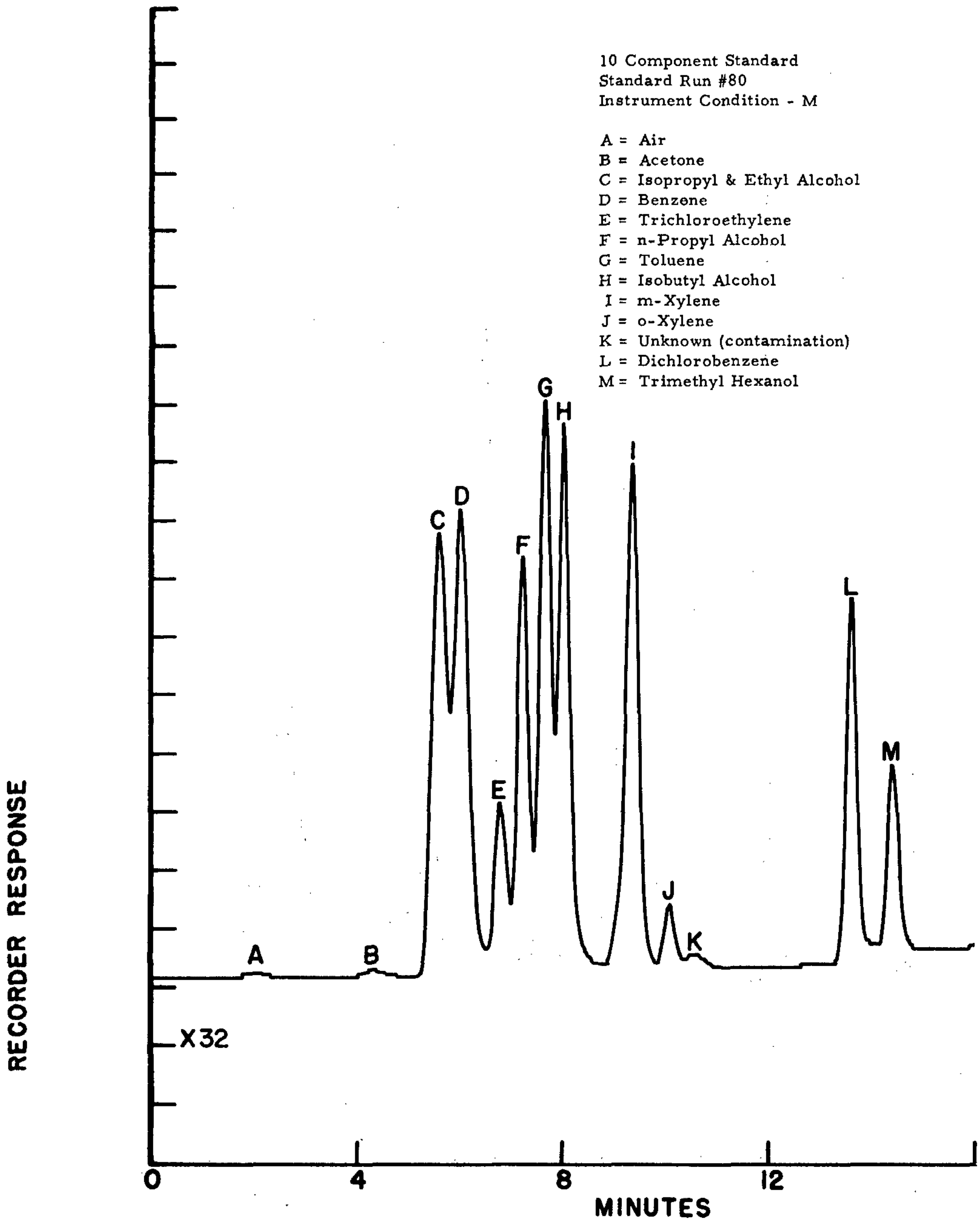


Figure 7. Gas Chromatogram of 10 Component Standard.

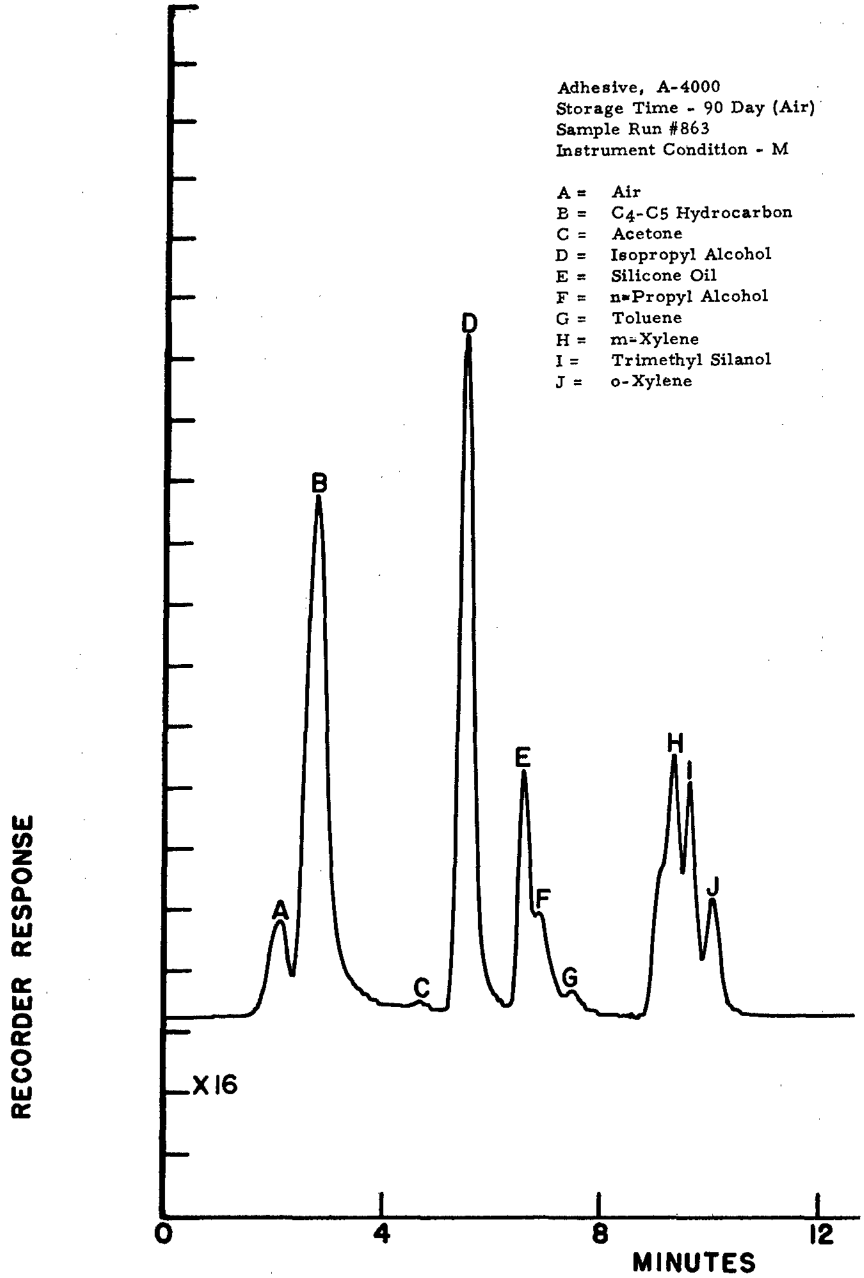


Figure 8. Gas Chromatogram of Gas-Off Products from Adhesive, A-4000 (90 Days, Air).

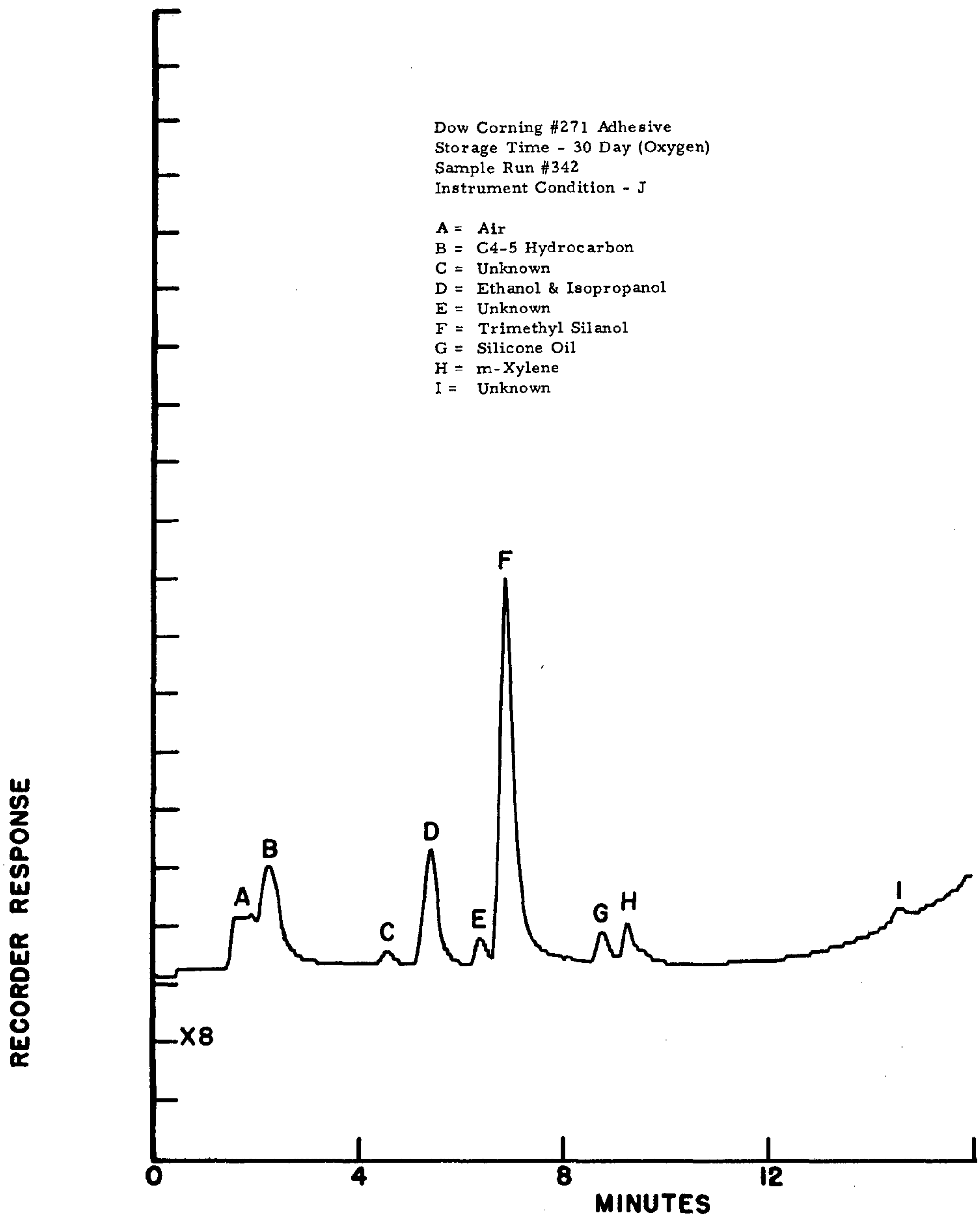


Figure 9. Gas Chromatogram of Gas-Off Products from Adhesive #271 (30 Days, Oxygen).

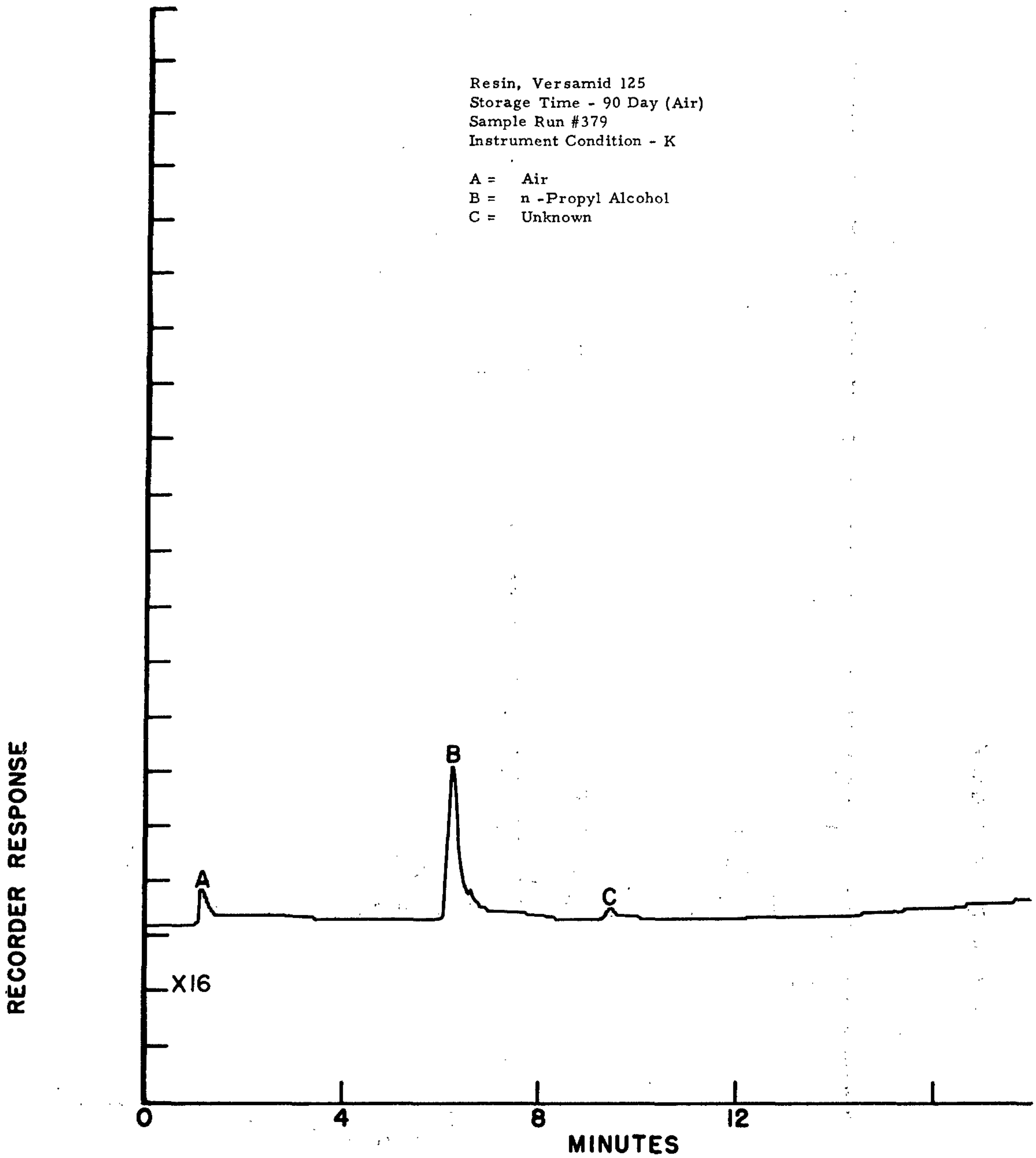


Figure 10. Gas Chromatogram of Gas-Off Products from Resin, Versamid 125 (90 Days, Air).

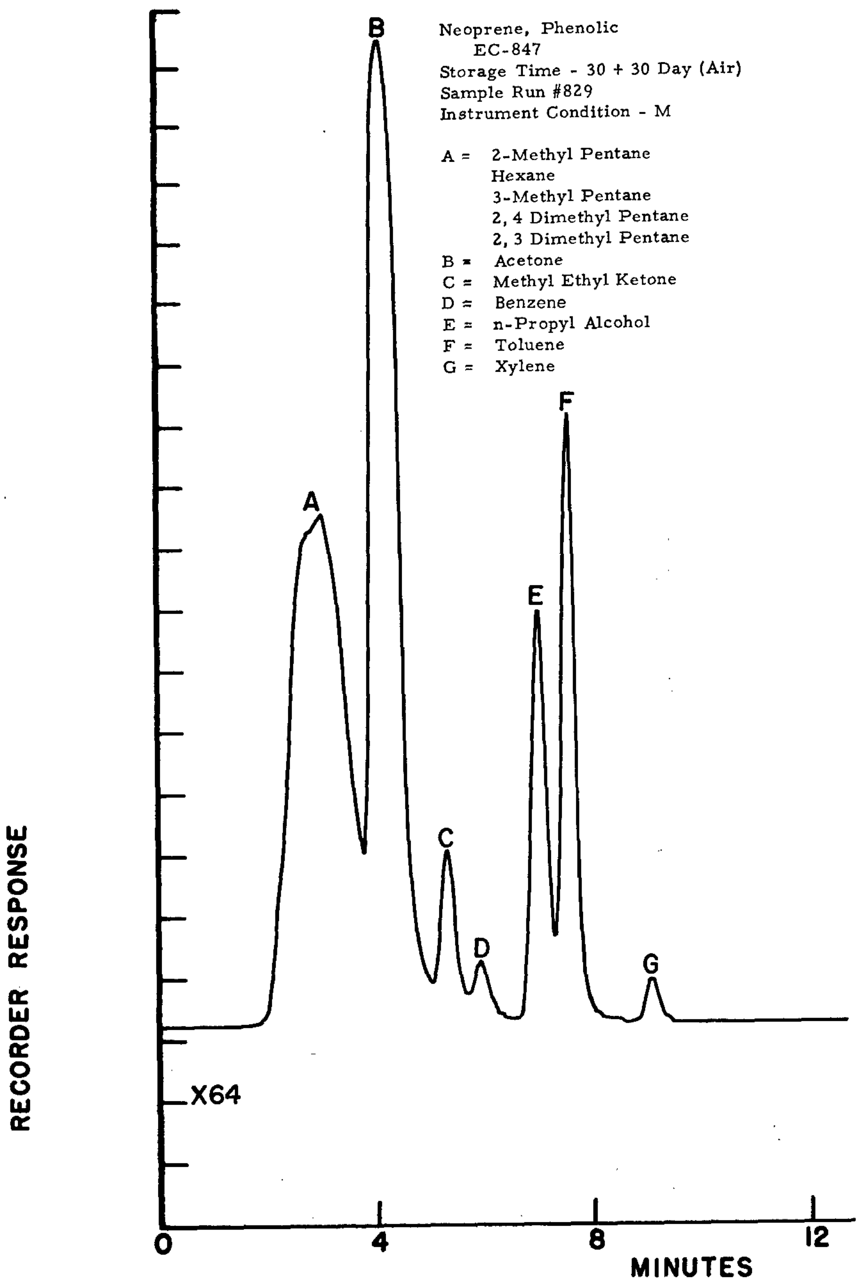


Figure 11. Gas Chromatogram of Gas-Off Products from Neoprene, Phenolic EC-847 (30 + 30 Days, Air).

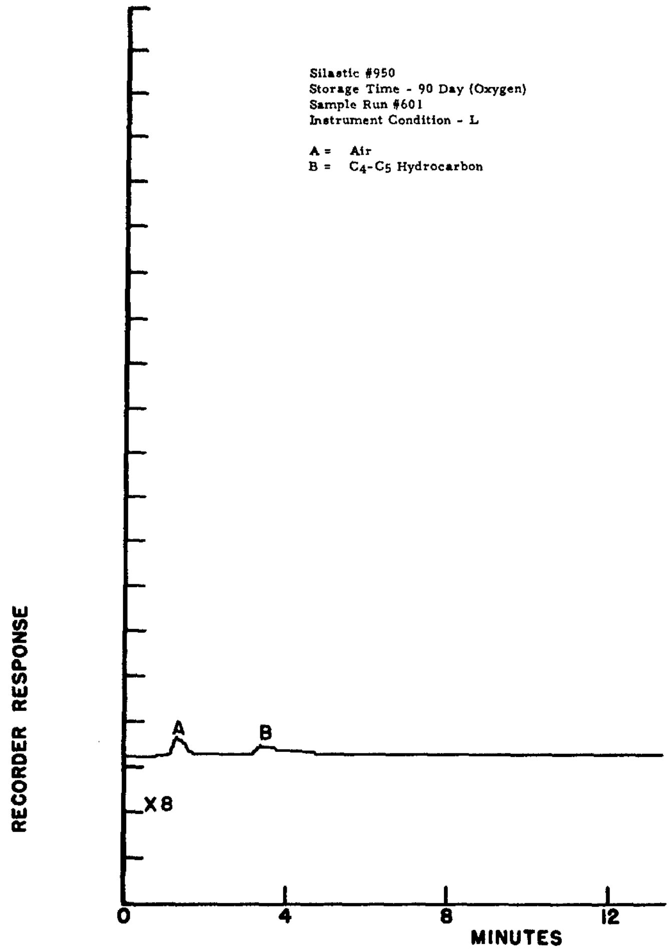


Figure 12. Gas Chromatogram of Gas-Off Products from Silastic #950 (90 Days, Oxygen).

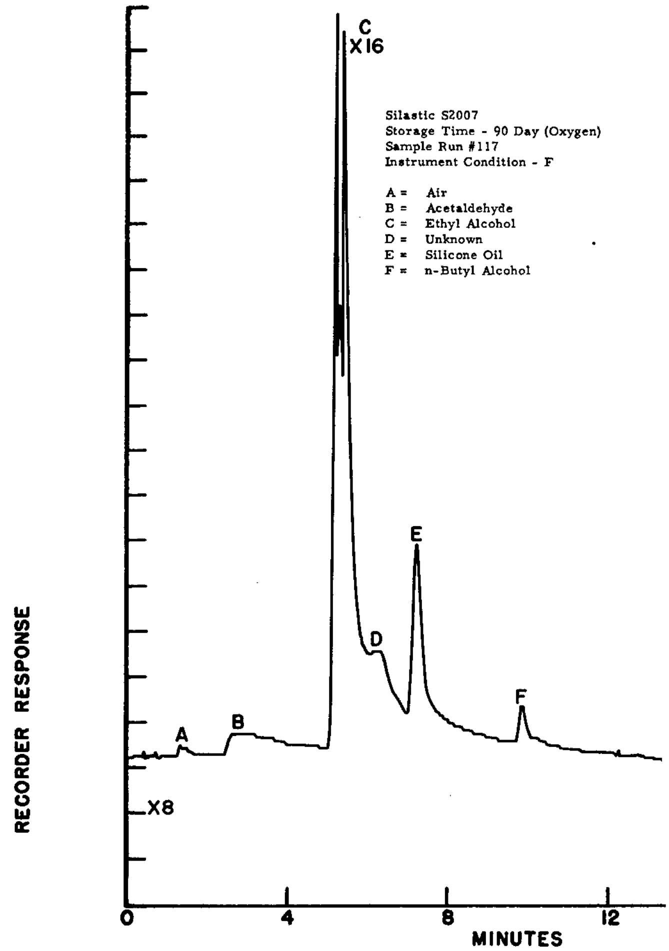


Figure 13. Gas Chromatogram of Gas-Off Products from Silastic S2007 (90 Days, Oxygen).

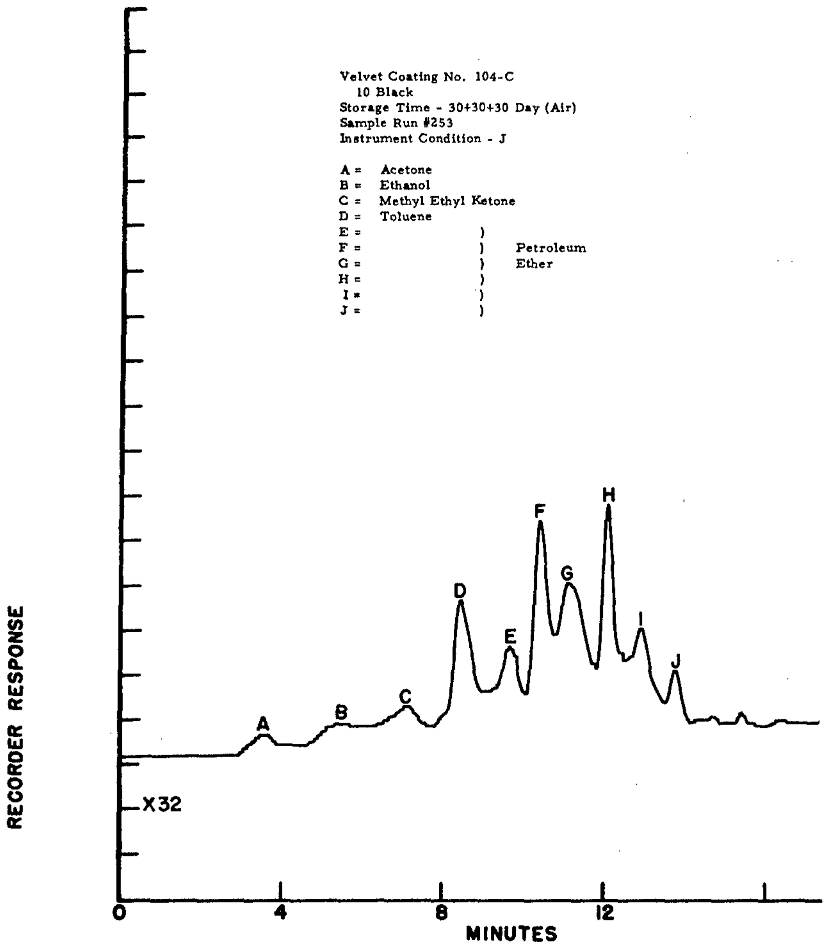


Figure 14. Gas Chromatogram of Gas-Off Products from Velvet Coating No. 104-C 10 Black (30 + 30 + 30 Days, Air).

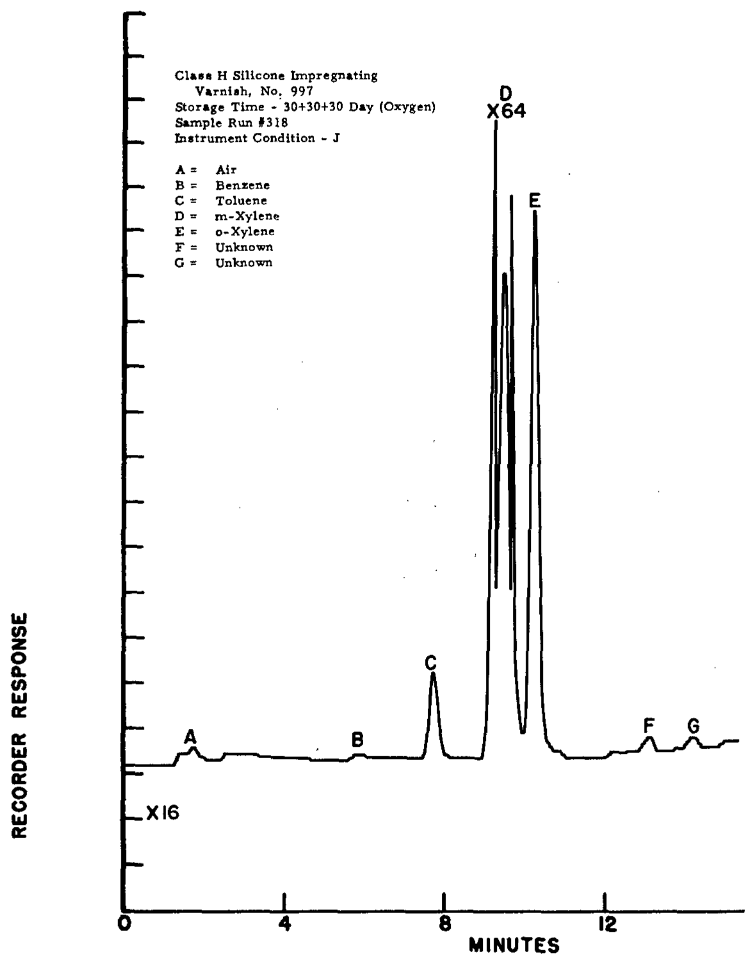


Figure 15. Gas Chromatogram of Gas-Off Products from Class H Silicone Impregnating Varnish, No. 997 (30 + 30 + 30 Days, Oxygen).

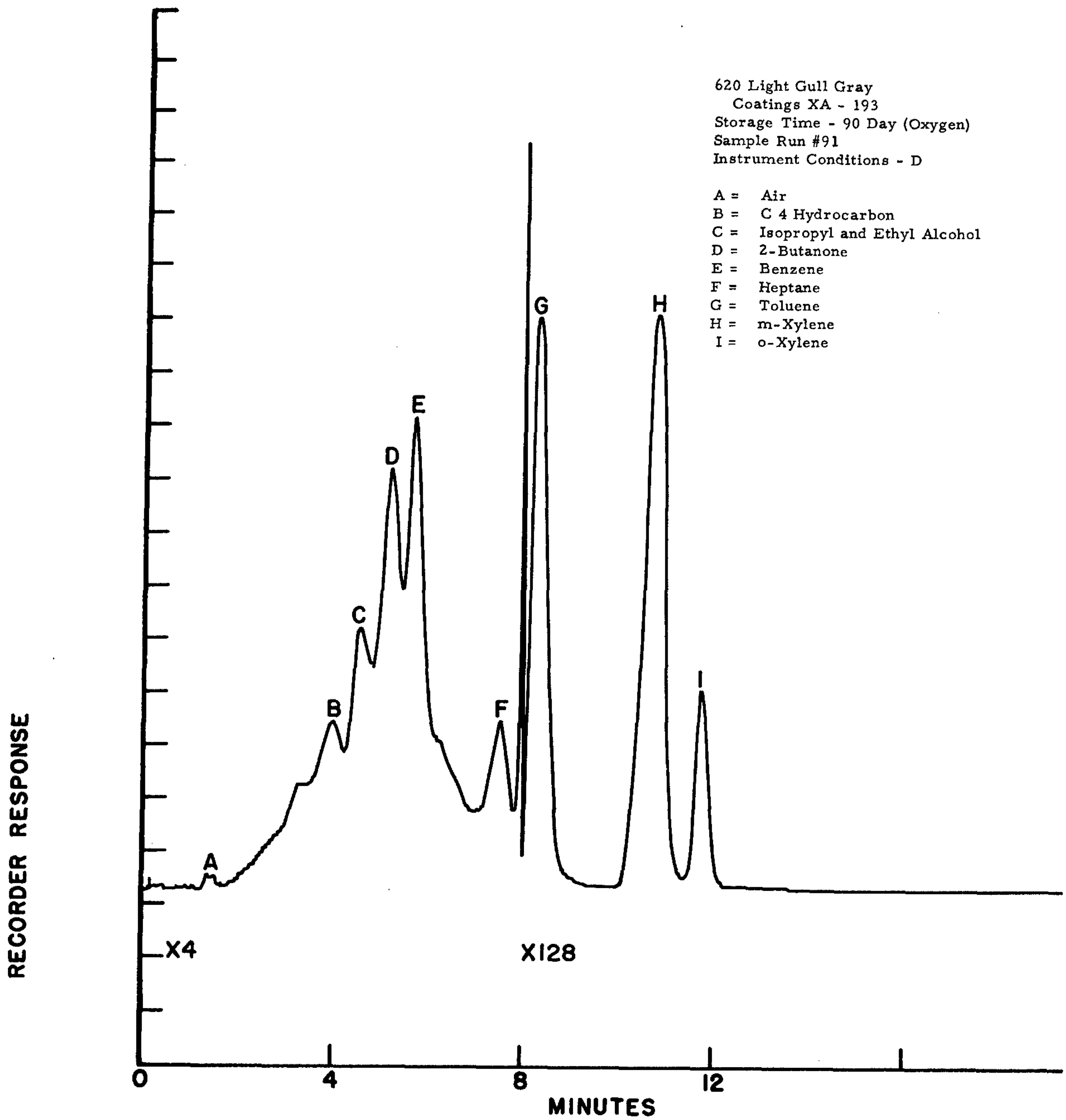


Figure 16. Gas Chromatogram of Gas-Off Products from 620 Light Gull Gray Coatings XA-193 (90 Days, Oxygen).

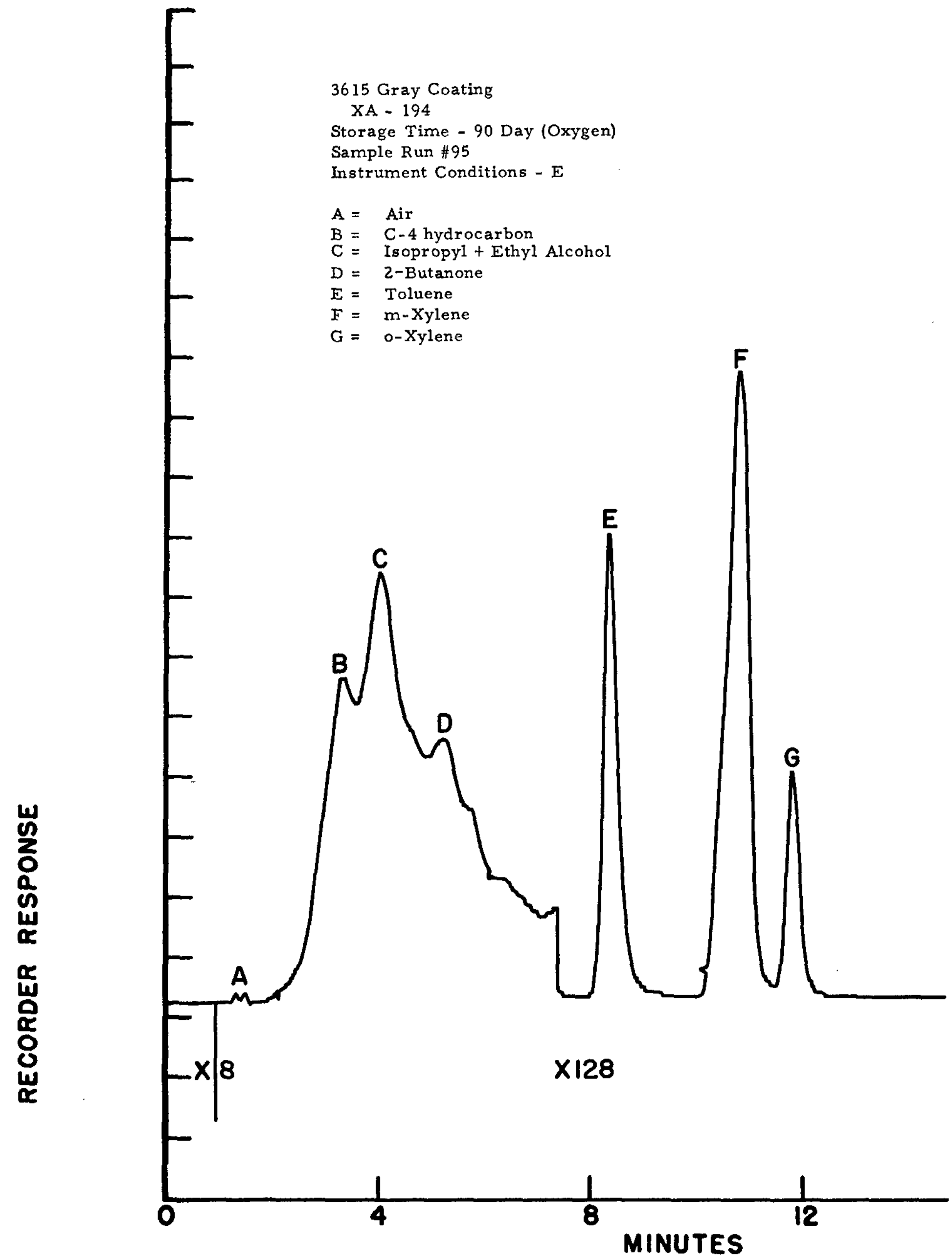


Figure 17. Gas Chromatogram of Gas-Off Products from 3615 Gray Coating XA-194 (90 Days, Oxygen).

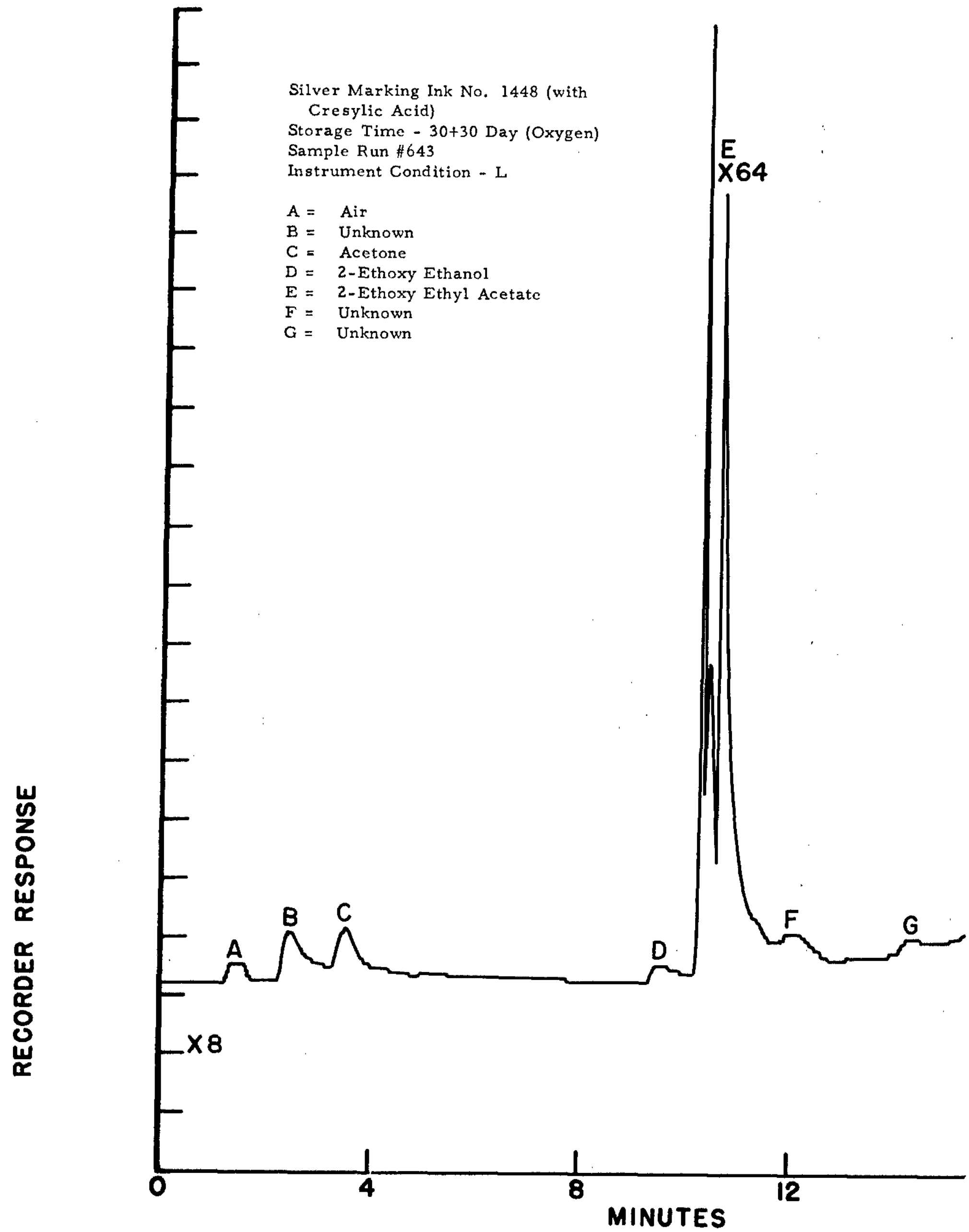


Figure 18. Gas Chromatogram of Gas-Off Products from Silver Marking Ink No. 1448 (with Cresylic Acid)(30 + 30 Days, Oxygen).

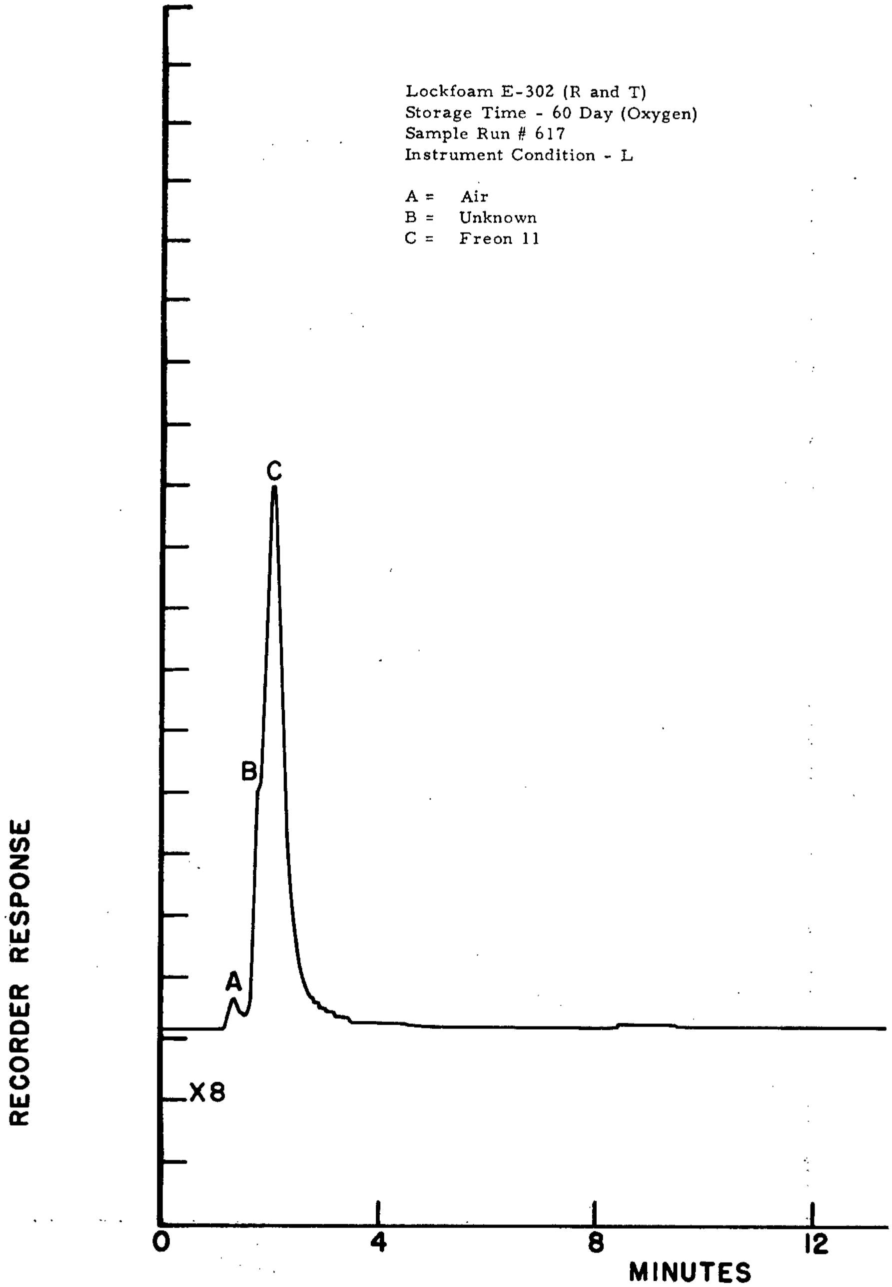


Figure 19. Gas Chromatogram of Gas-Off Products from Lockfoam E-302 (R and T) (60 Days, Oxygen).

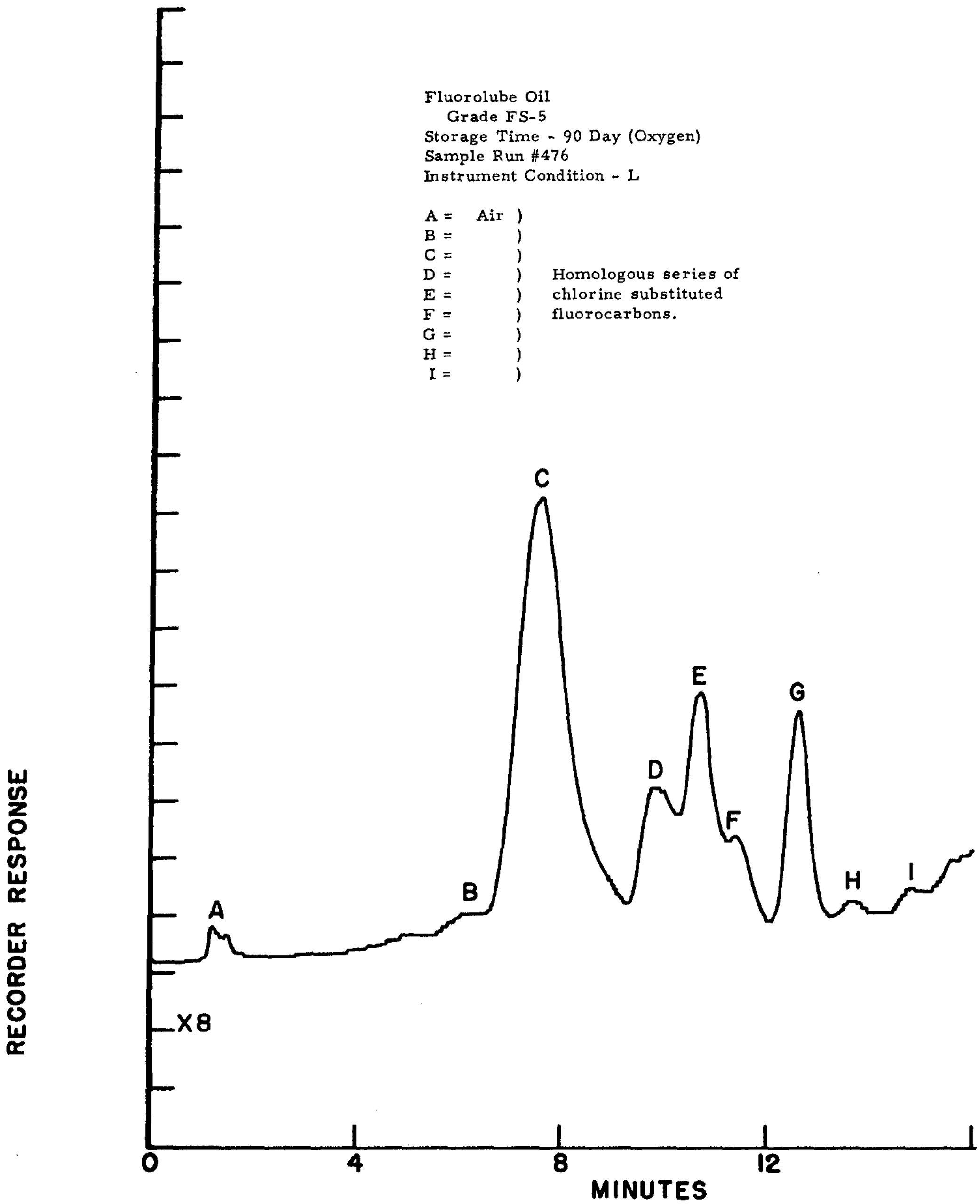


Figure 20. Gas Chromatogram of Gas-Off Products from Fluorolube Oil Grade FS-5 (90 Days, Oxygen).

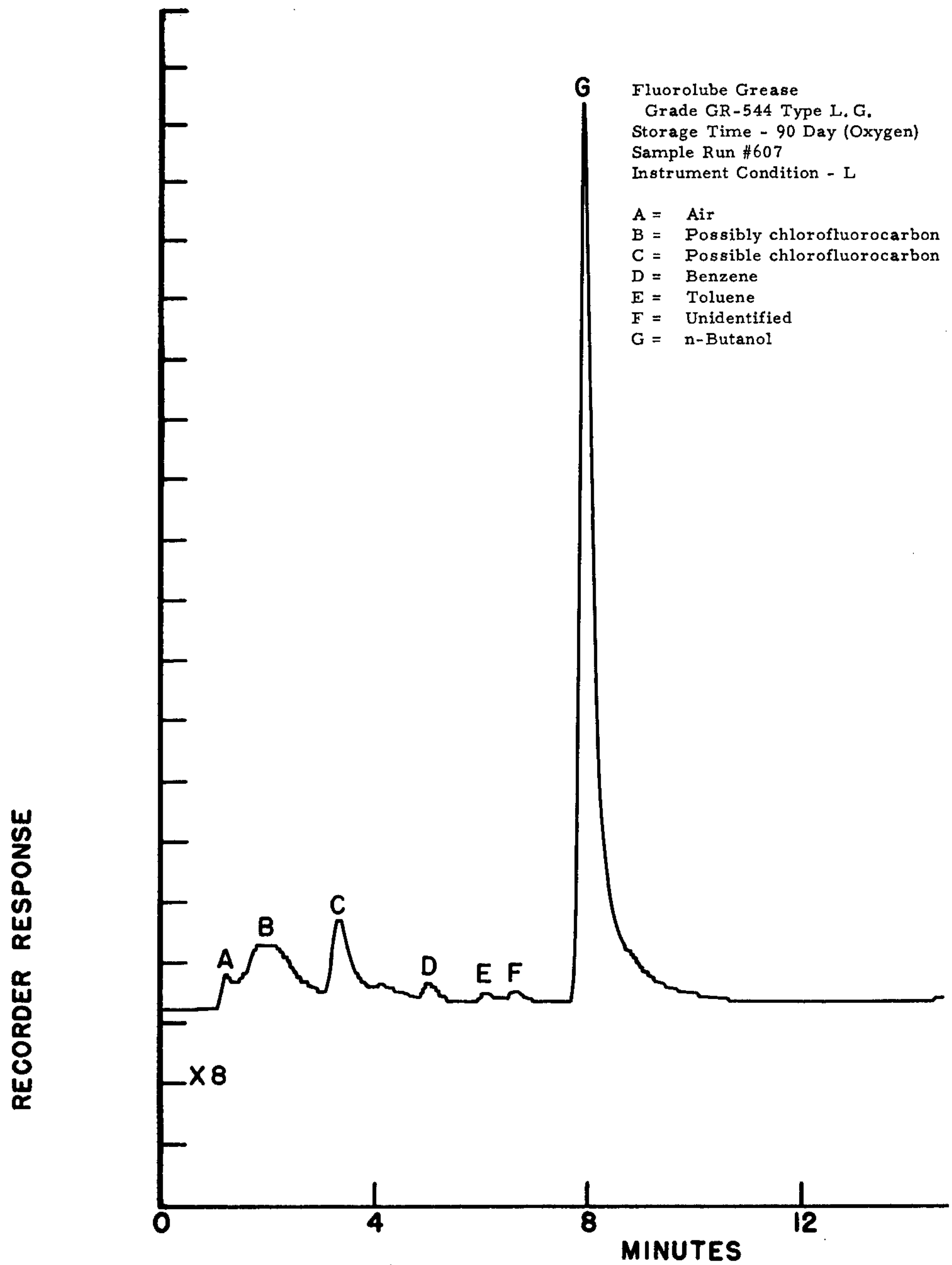


Figure 21. Gas Chromatogram of Gas-Off Products from Fluorolube Grease Grade GR-544 Type L.G. (90 Days, Oxygen).

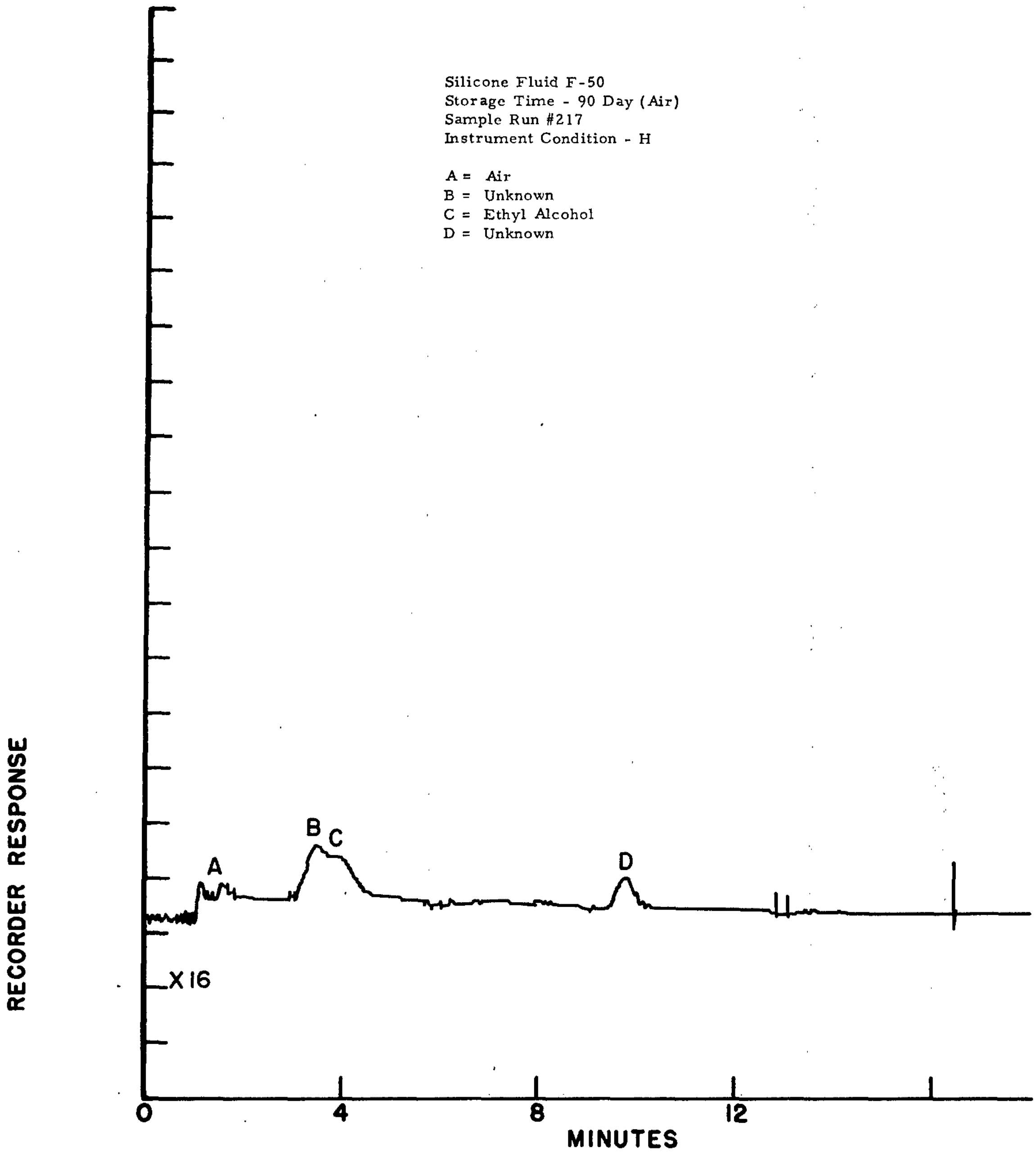


Figure 22. Gas Chromatogram of Gas-Off Products from Silicone Fluid F-50 (90 Days, Air).

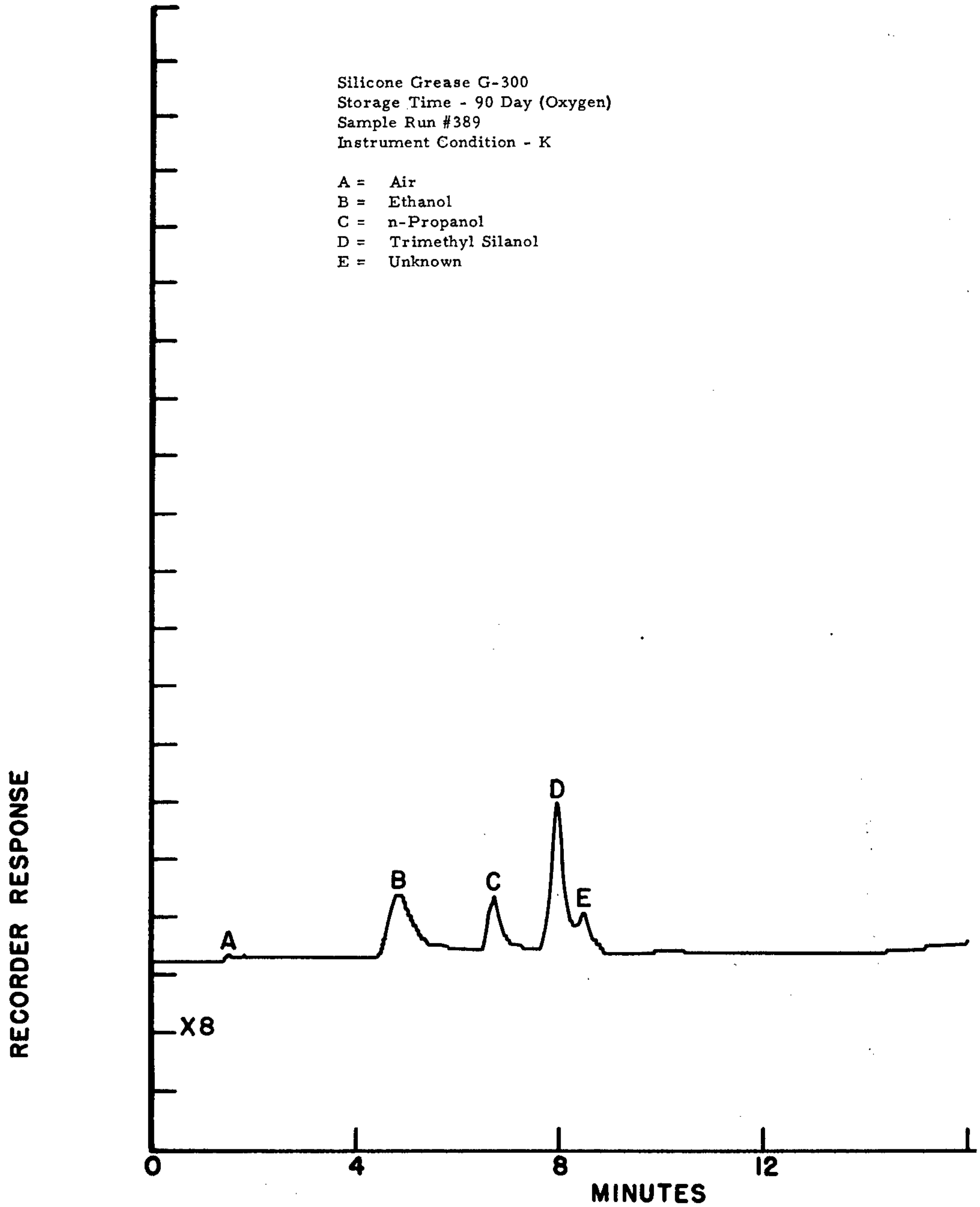


Figure 23. Gas Chromatogram of Gas-Off Products from Silicone Grease G-300 (90 Days, Oxygen).

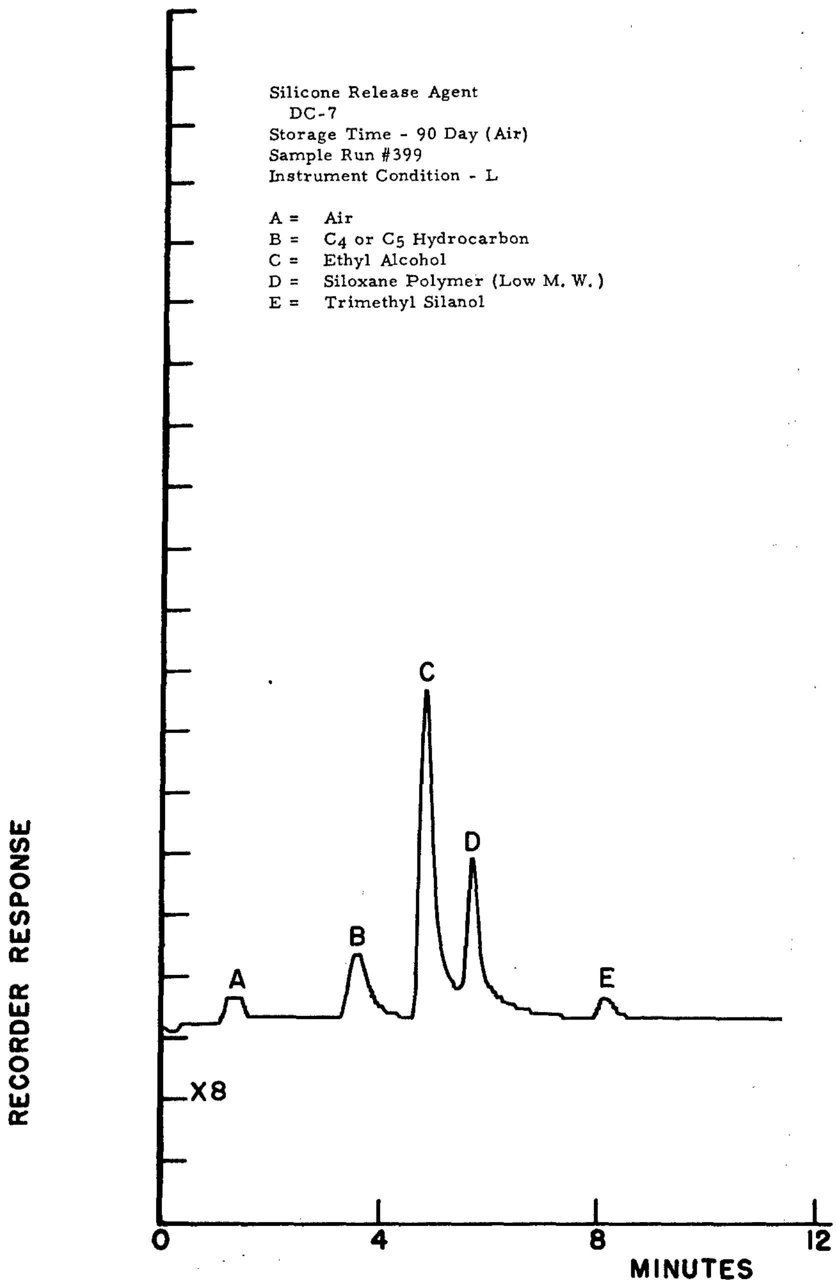


Figure 24. Gas Chromatogram of Gas-Off Products from Silicone Release Agent DC-7 (90 Days, Air).

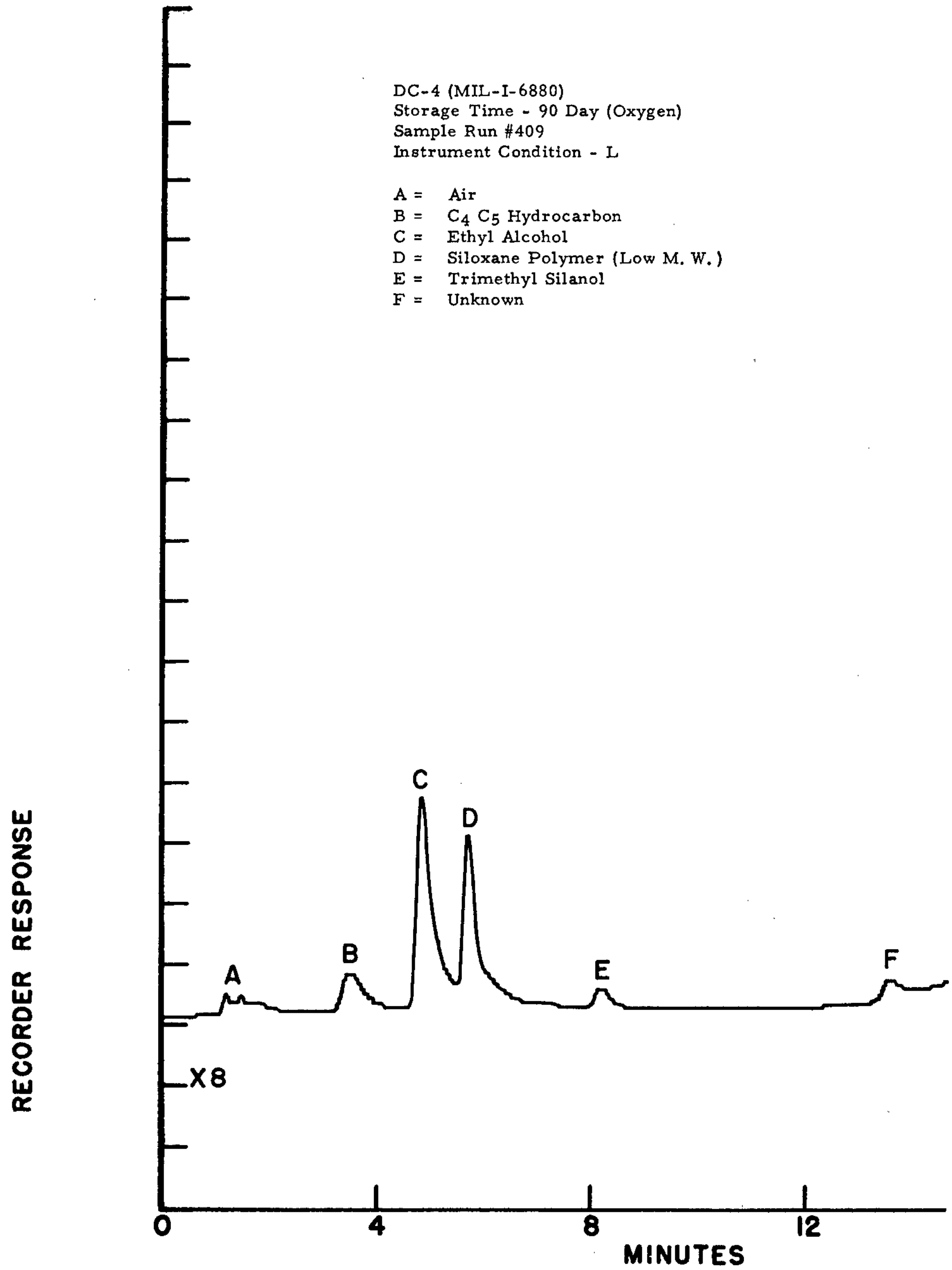


Figure 25. Gas Chromatogram of Gas-Off Products from DC-4 (MIL-I-6880) (90 Days, Oxygen).

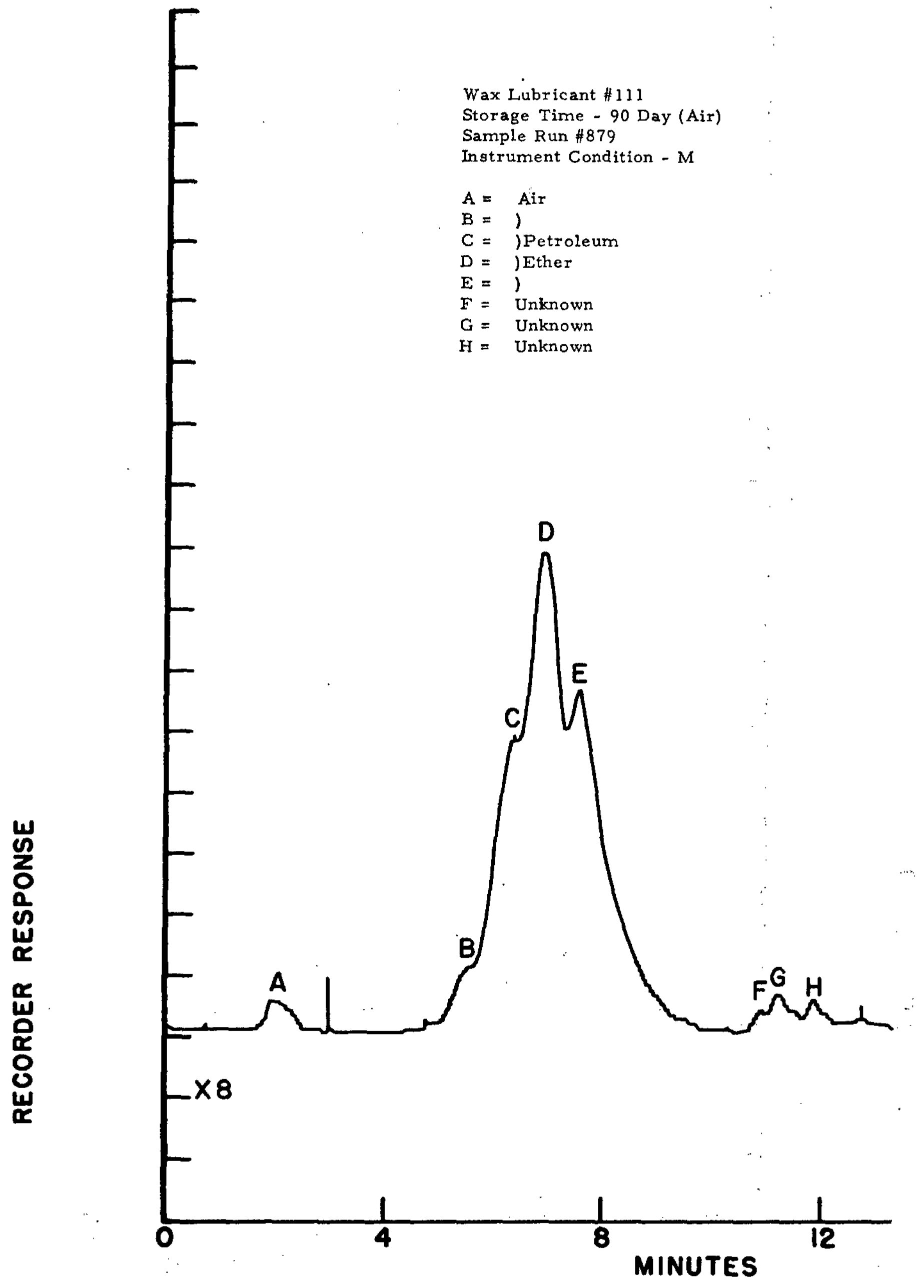


Figure 26. Gas Chromatogram of Gas-Off Products from Wax Lubricant #111 (90 Days, Air).

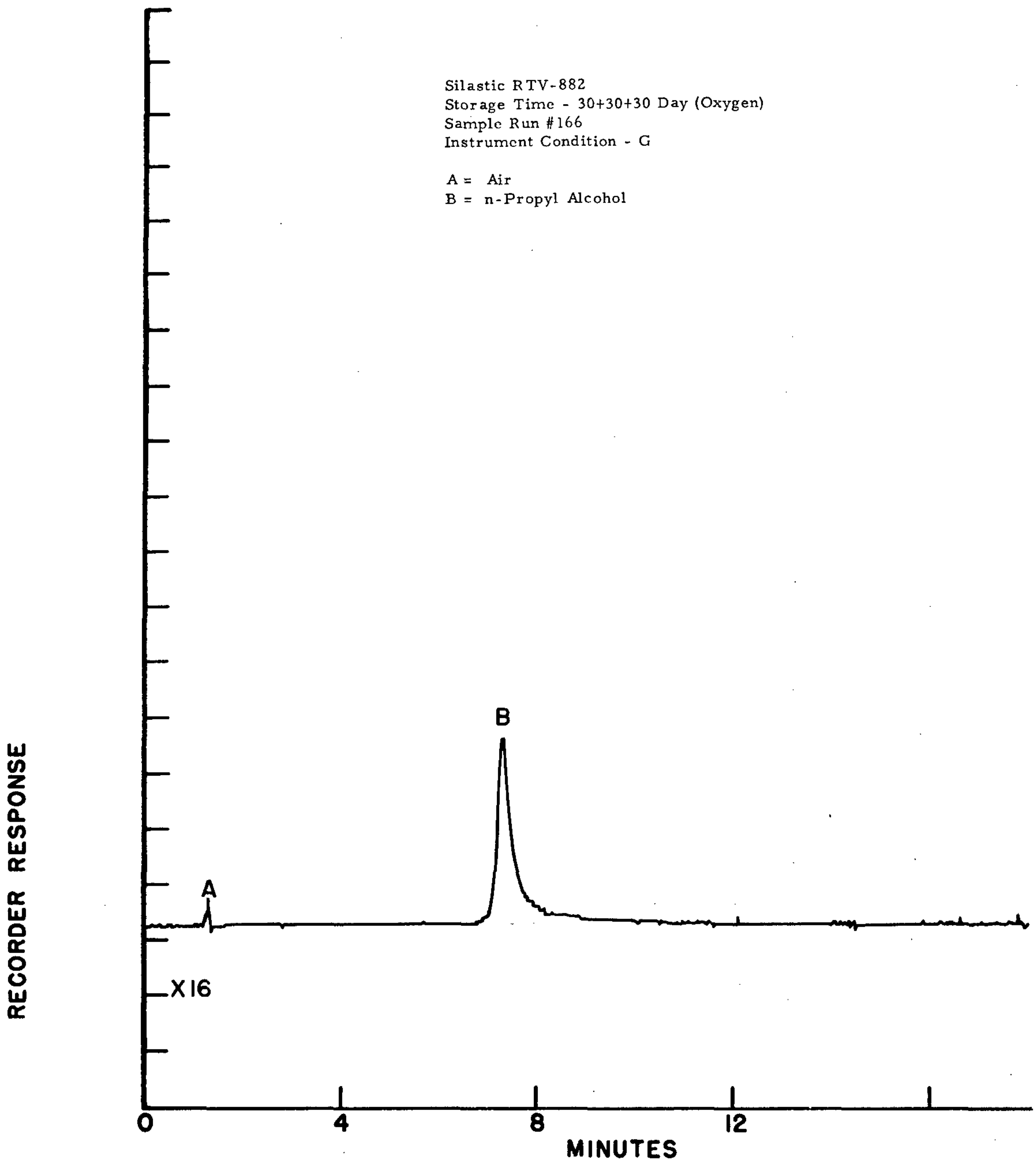


Figure 27. Gas Chromatogram of Gas-Off Products from Silastic RTV-882 (30 + 30 + 30 Days, Oxygen).

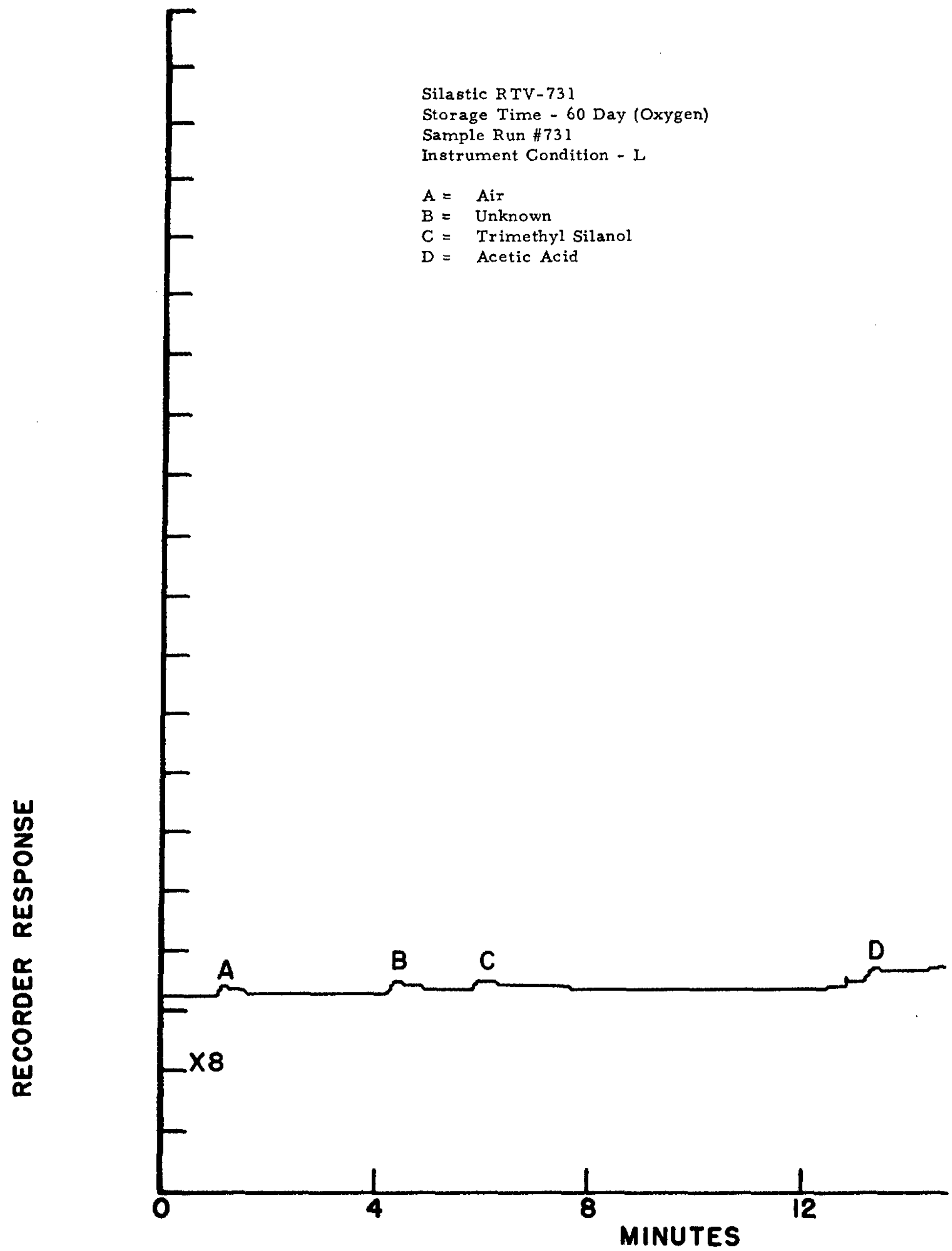


Figure 28. Gas Chromatogram of Gas-Off Products from Silastic RTV-731 (60 Days, Oxygen).

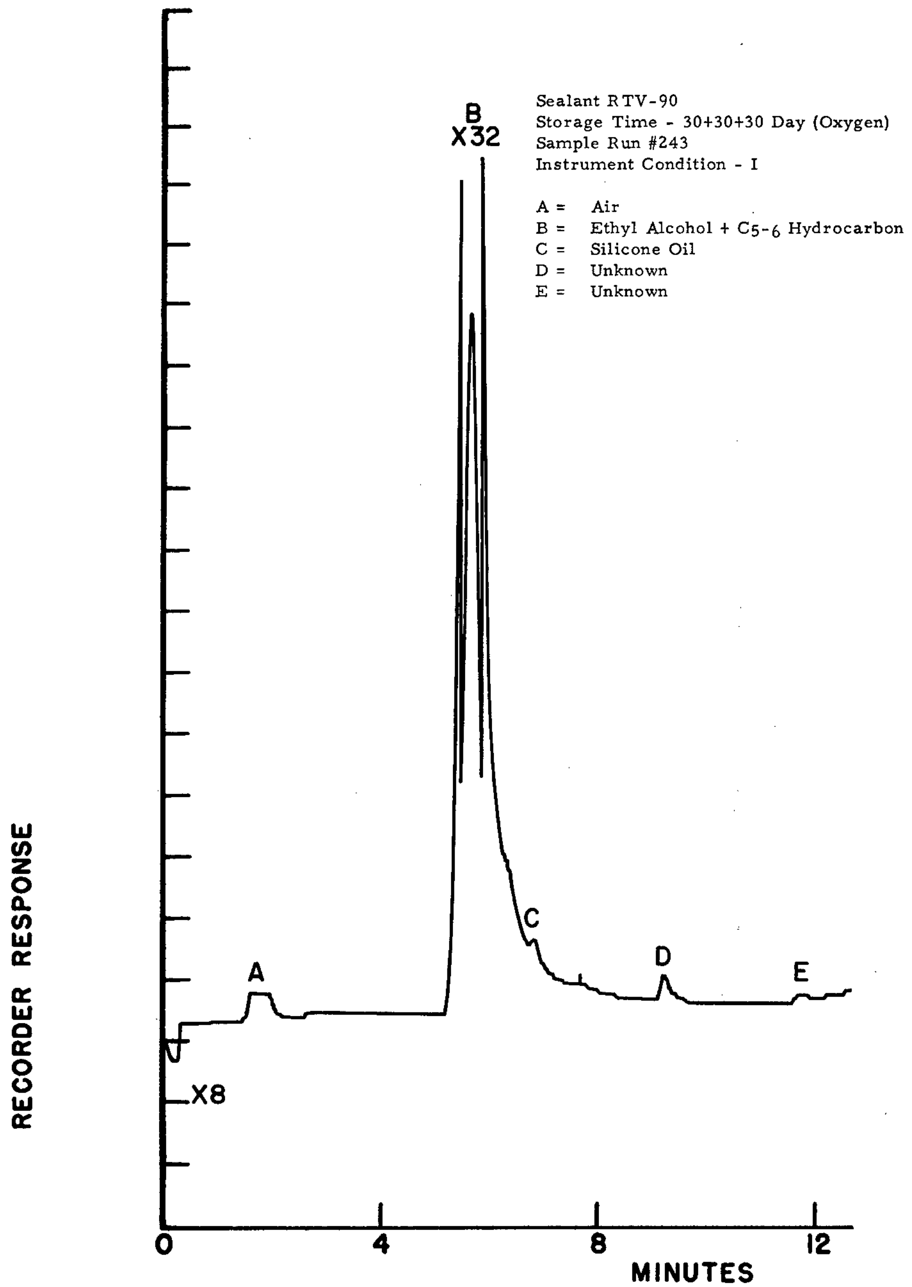


Figure 29. Gas Chromatogram of Gas-Off Products from Sealant RTV-90 (30 + 30 + 30 Days, Oxygen).

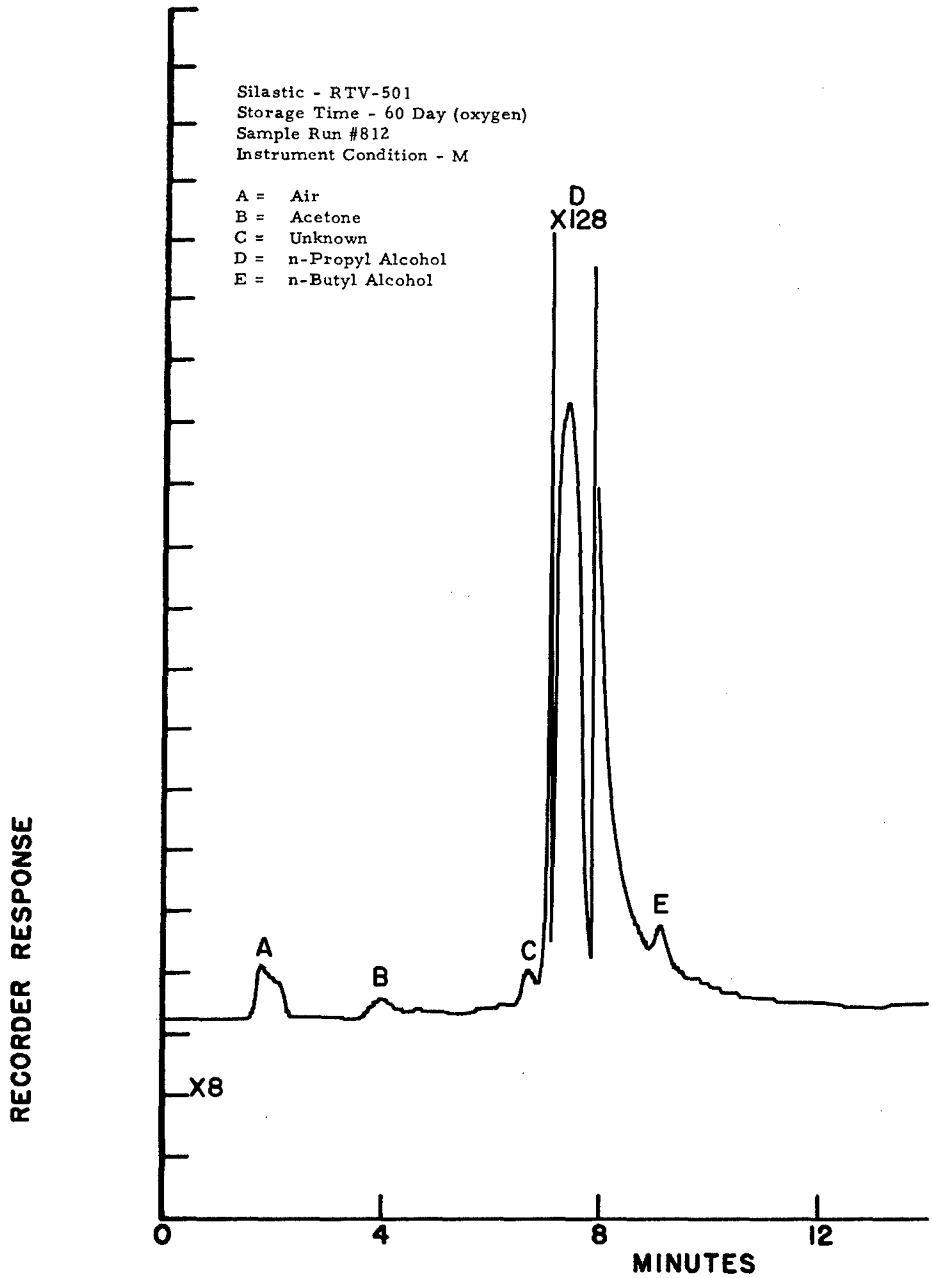


Figure 30. Gas Chromatogram of Gas-Off Products from Silastic RTV-501 (60/Days, oxygen).

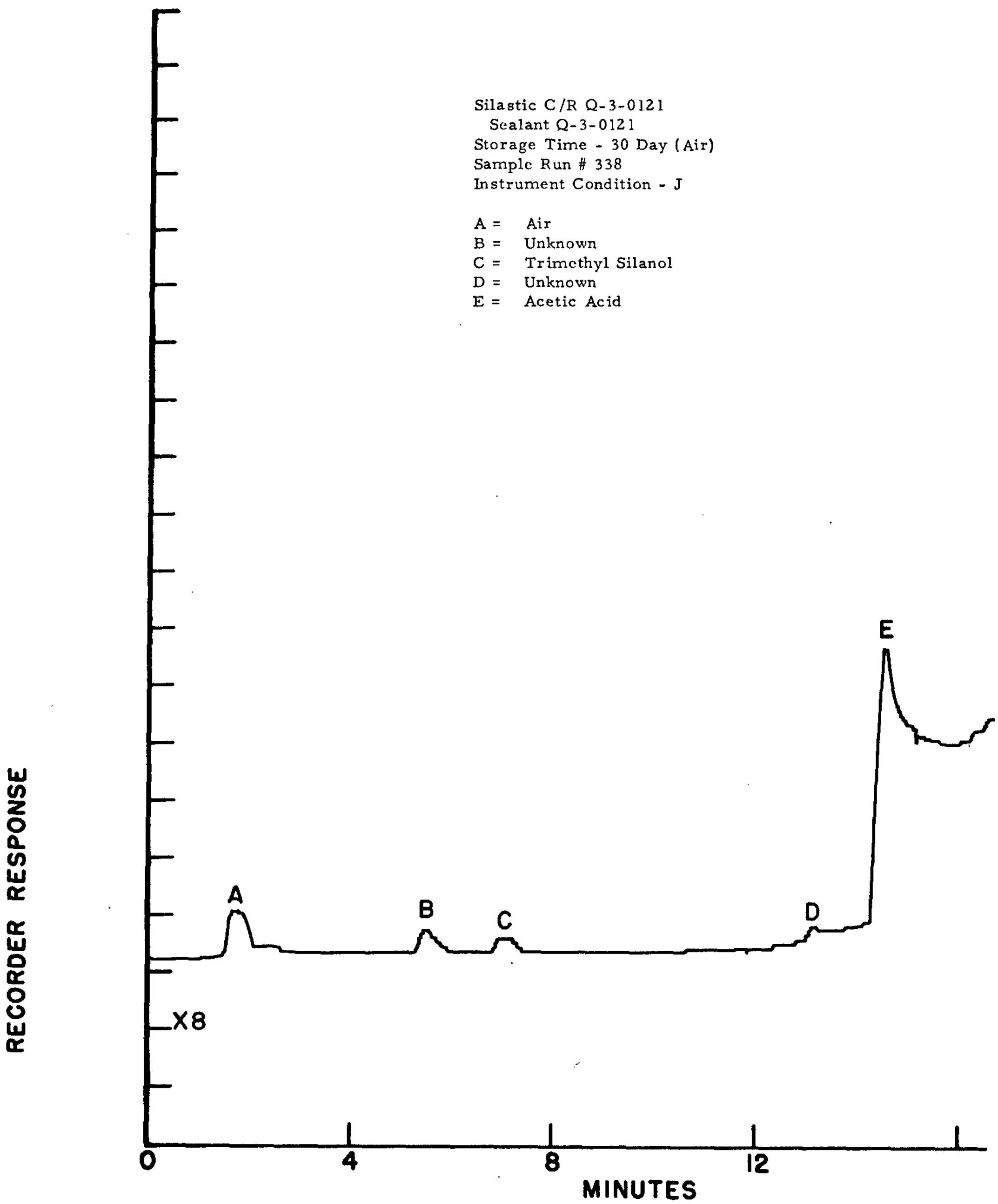


Figure 31. Gas Chromatogram of Gas-Off Products from Silastic C/R Q-3-0121 - Sealant Q-3-0121 (30 Days, Air).

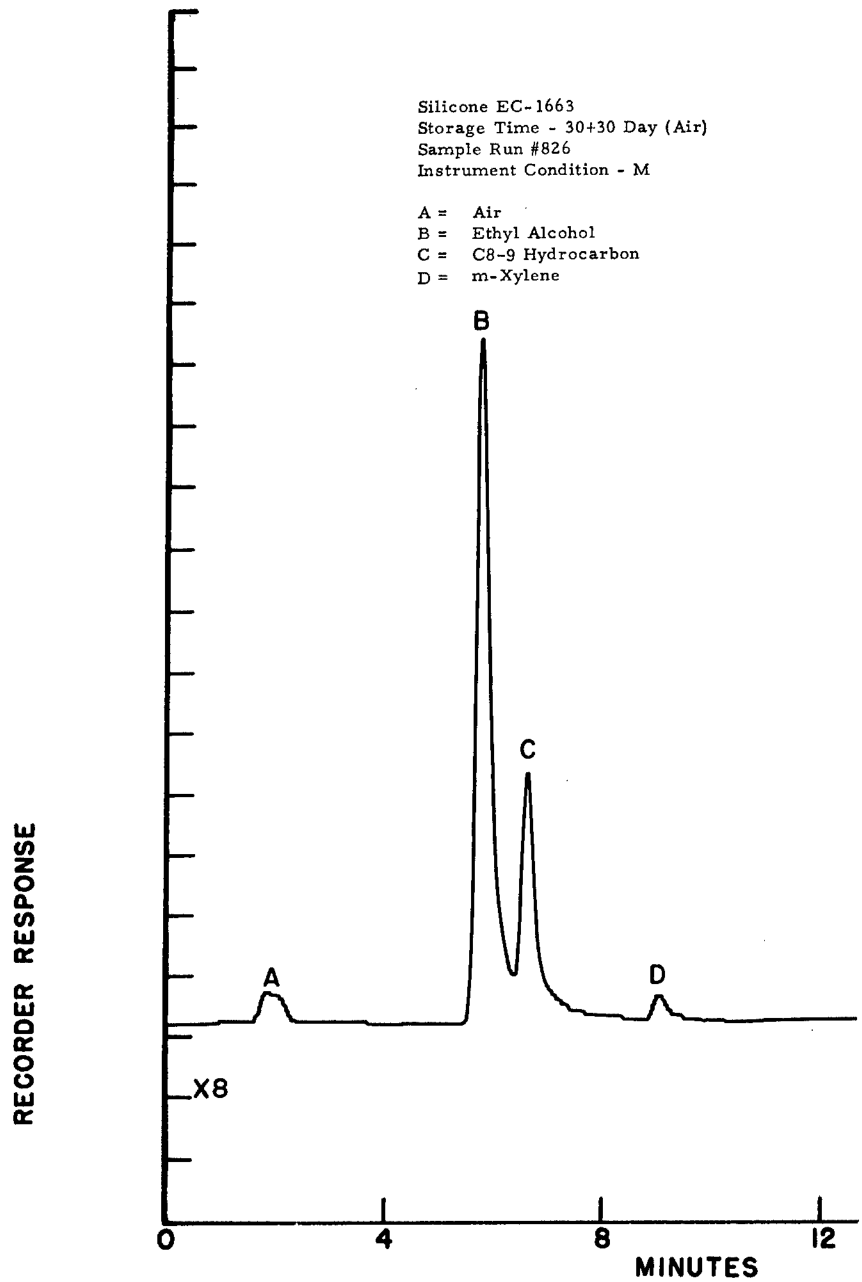


Figure 32. Gas Chromatogram of Gas-Off Products from Silicone EC-1663 (30 + 30 Days, Air).

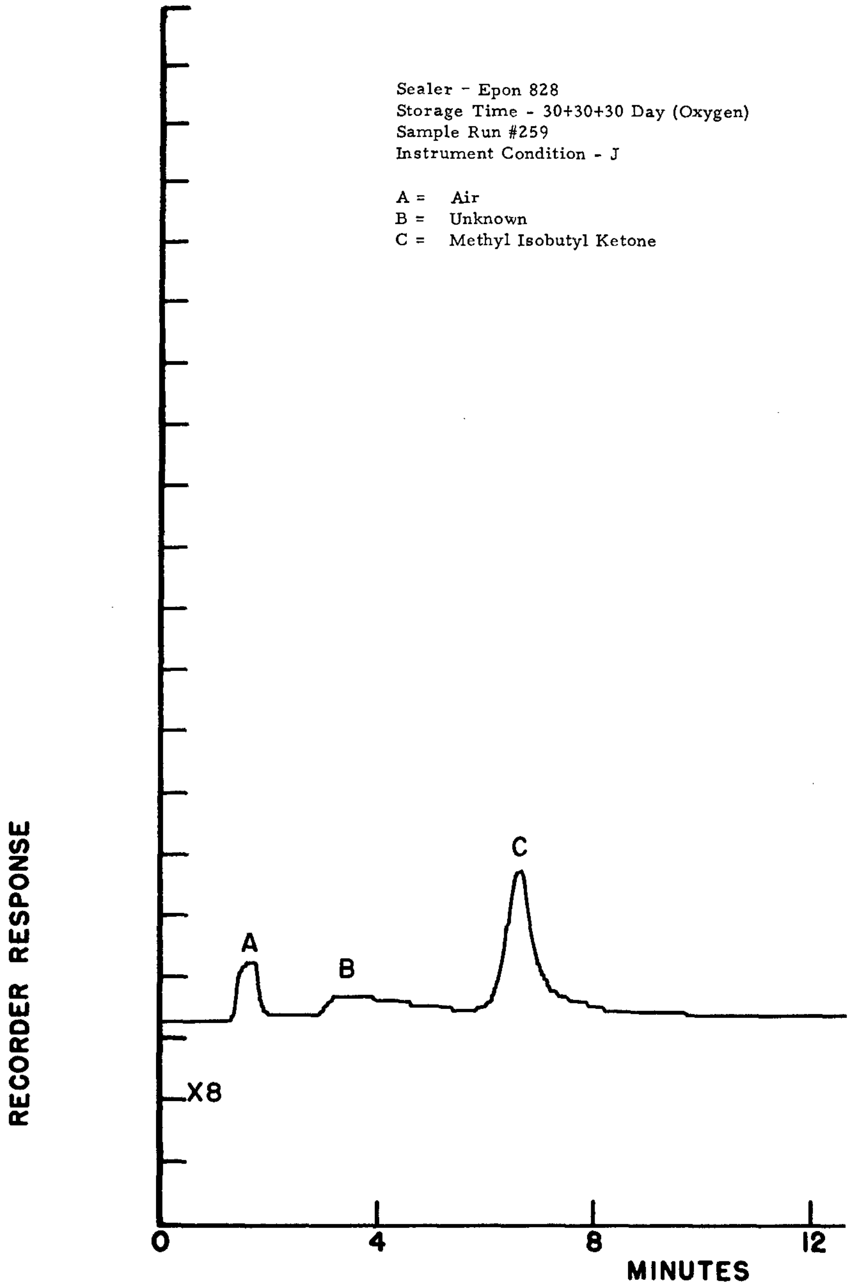


Figure 33. Gas Chromatogram of Gas-Off Products from Sealer - Epon 828 (30 + 30 + 30 Days, Oxygen).

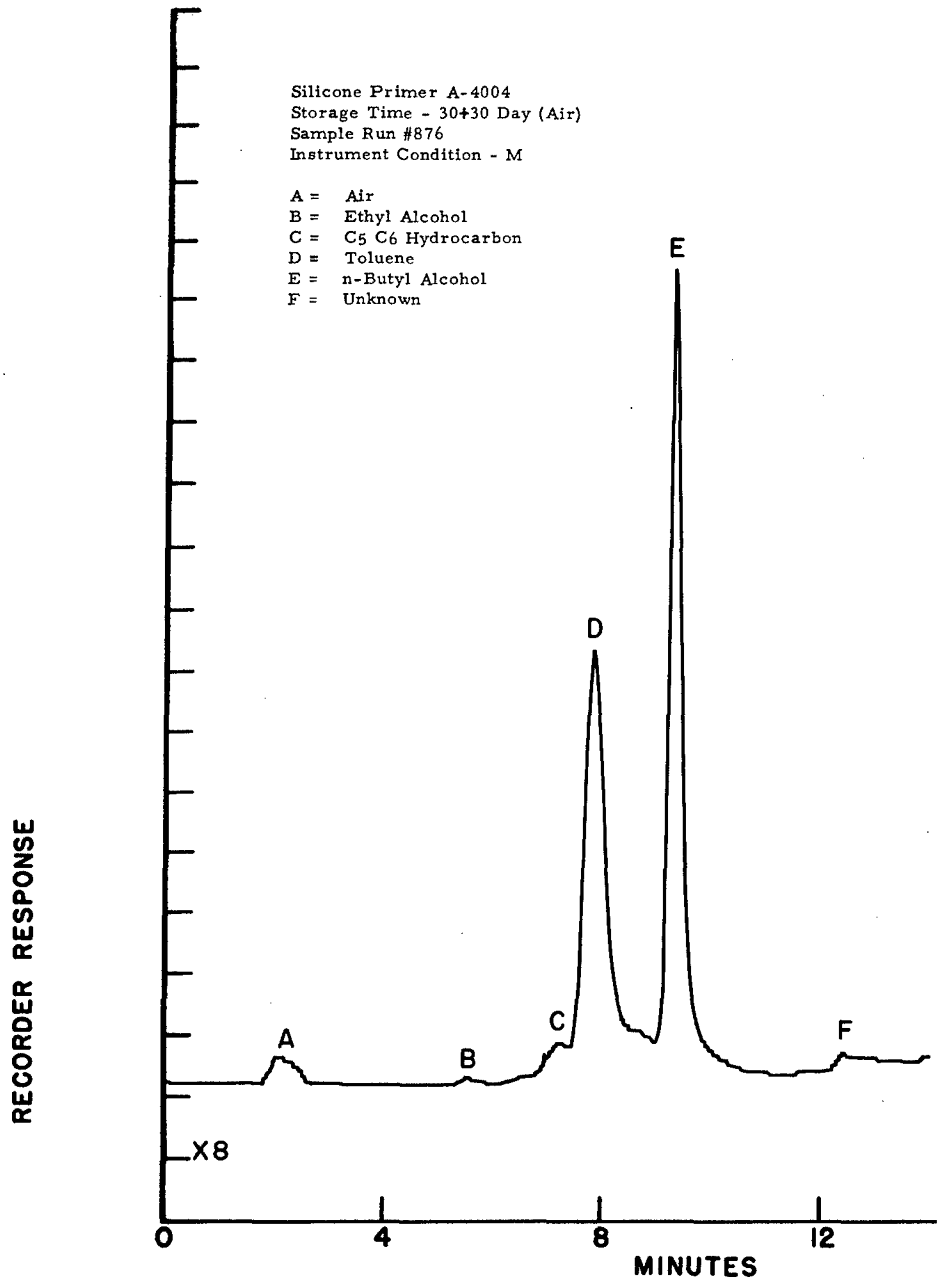


Figure 34. Gas Chromatogram of Gas-Off Products from Silicone Primer A-4004 (30 + 30 Days, Air).

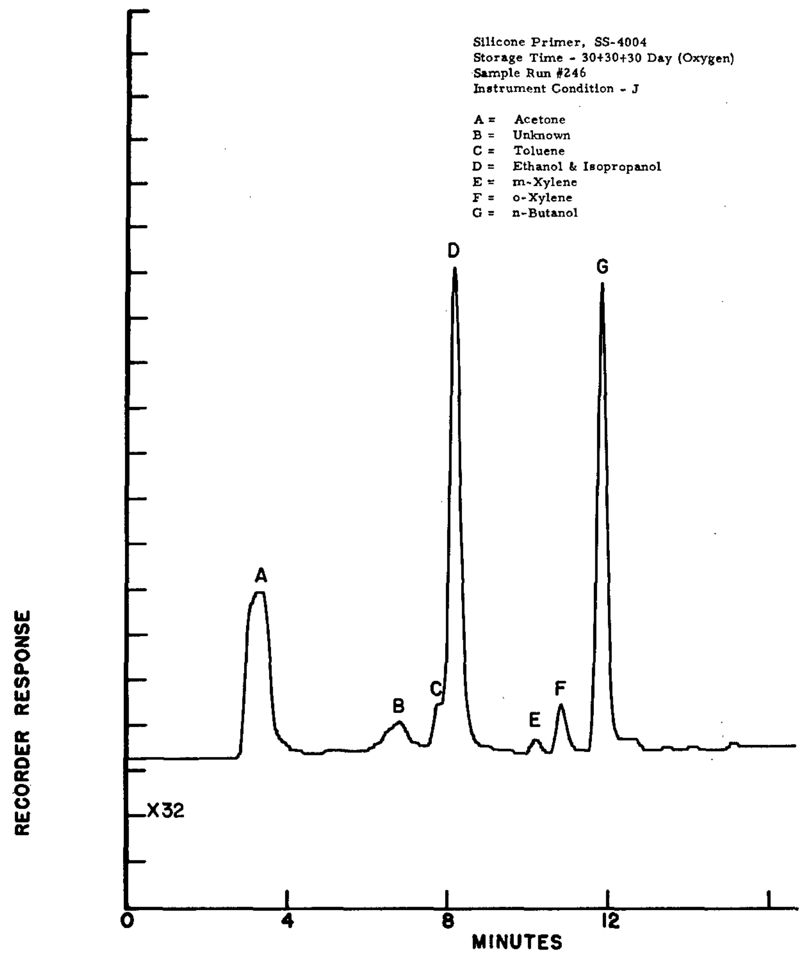


Figure 35. Gas Chromatogram of Gas-Off Products from Silicone Primer SS-4004 (30 + 30 + 30 Days, Oxygen).

Note: See Standard #30.

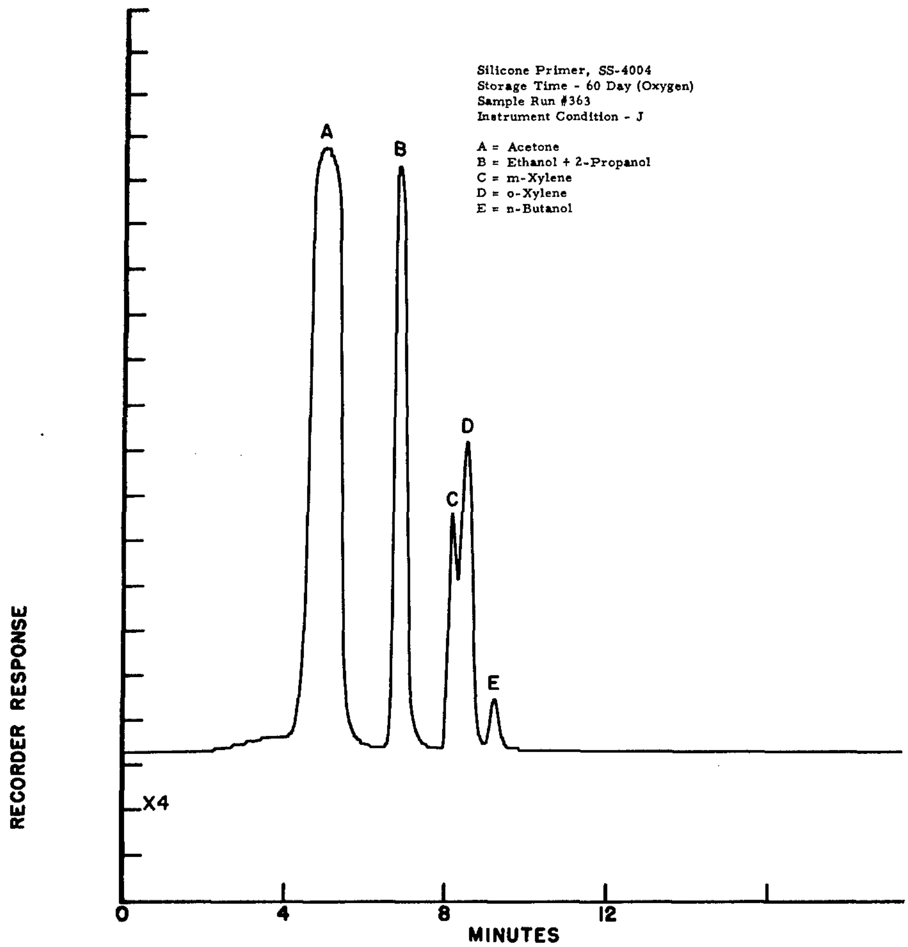


Figure 36. Gas Chromatogram of Gas-Off Products from Silicone Primer SS-4004 (60 Days, Oxygen).

Note: See Standard #43.

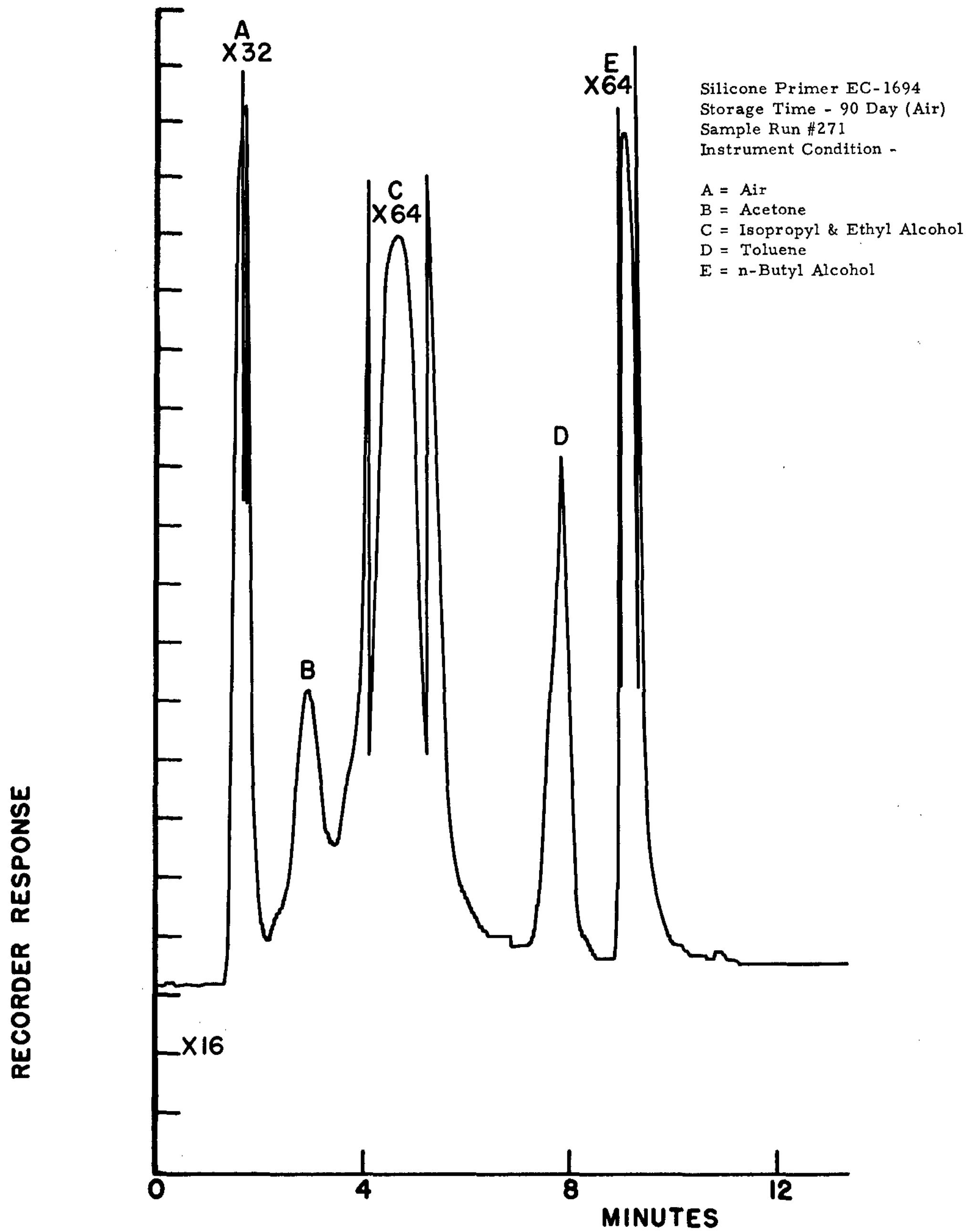


Figure 37. Gas Chromatogram of Gas-Off Products from Silicone Primer EC-1694 (90 Days, Air).

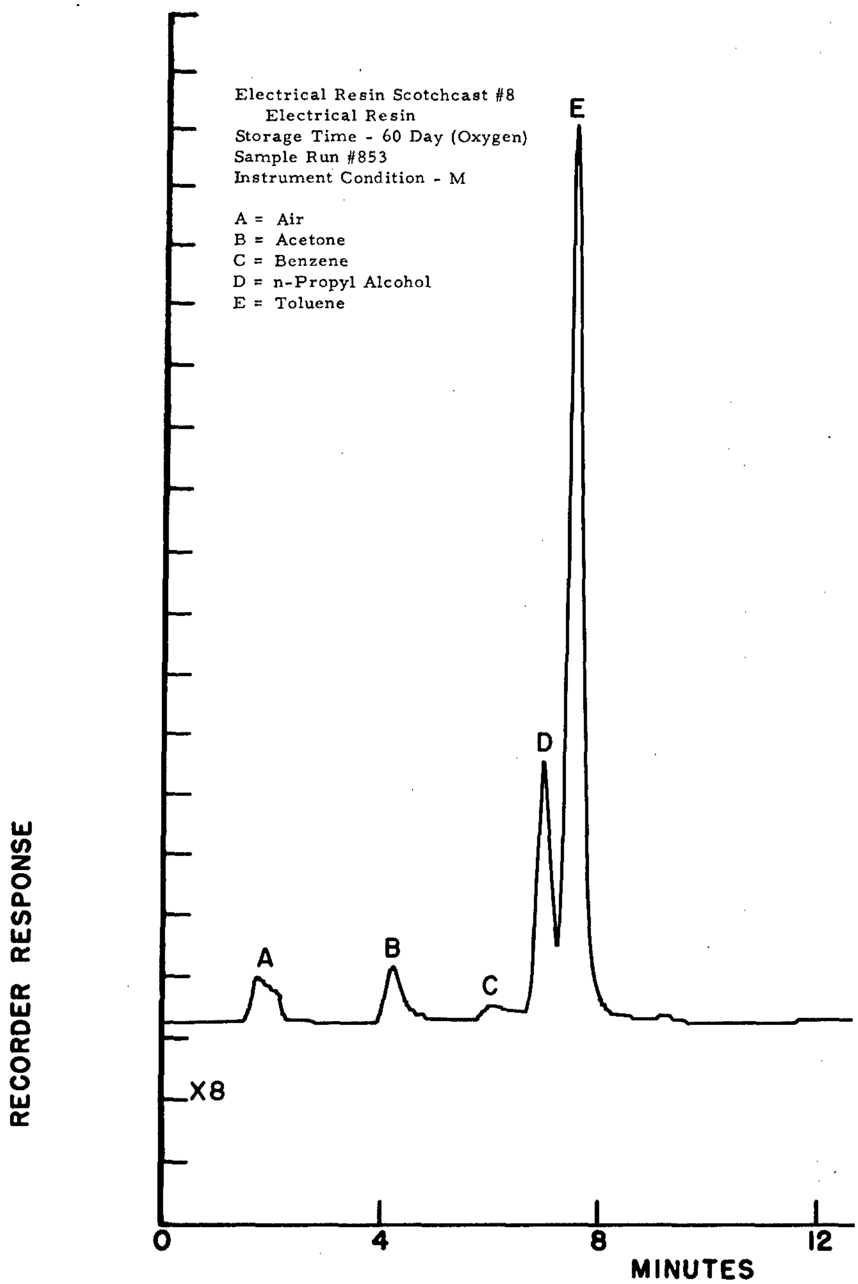


Figure 38. Gas Chromatogram of Gas-Off Products from Electrical Resin Scotchcast #8 (60 Days, Oxygen).

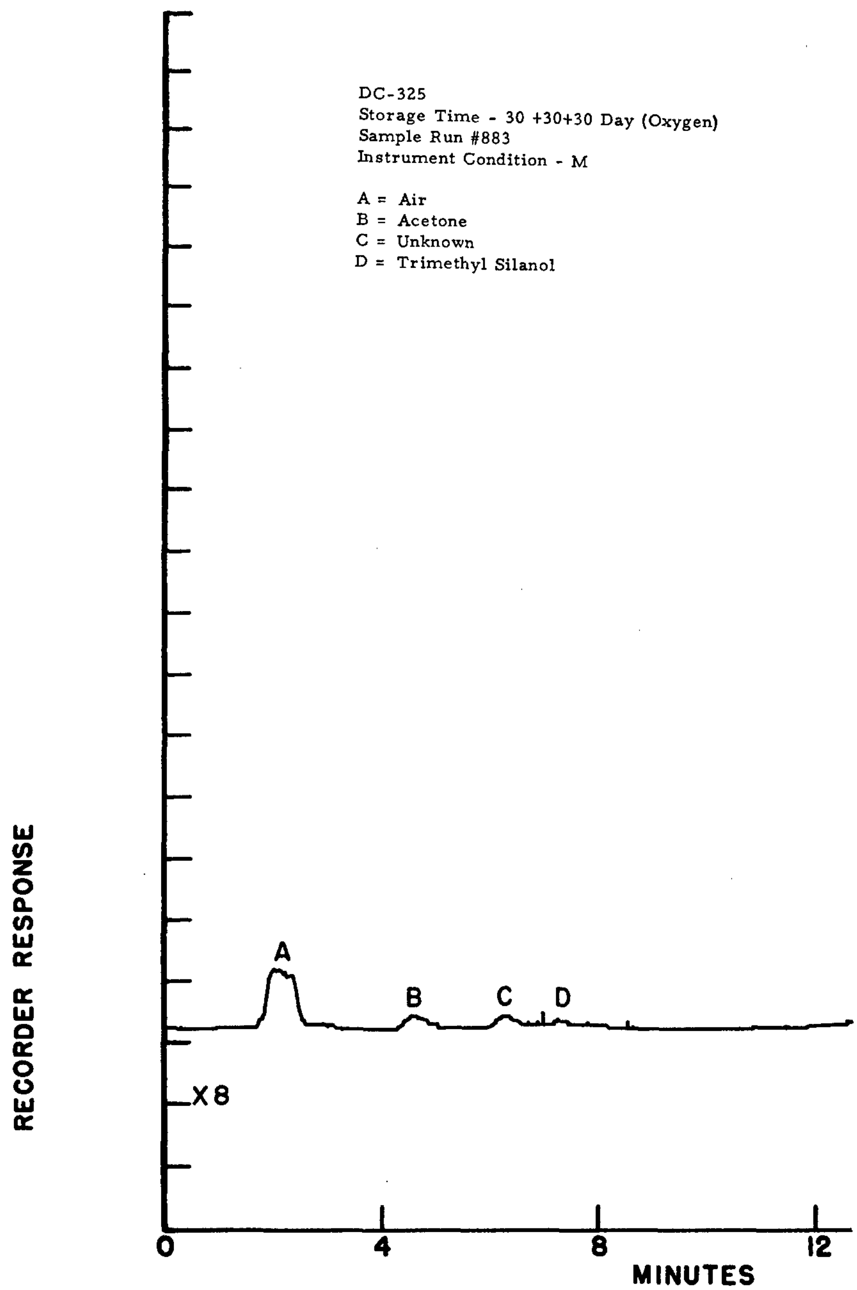


Figure 39. Gas Chromatogram of Gas-Off Products from DC-325 (30 + 30 + 30 Days, Oxygen).

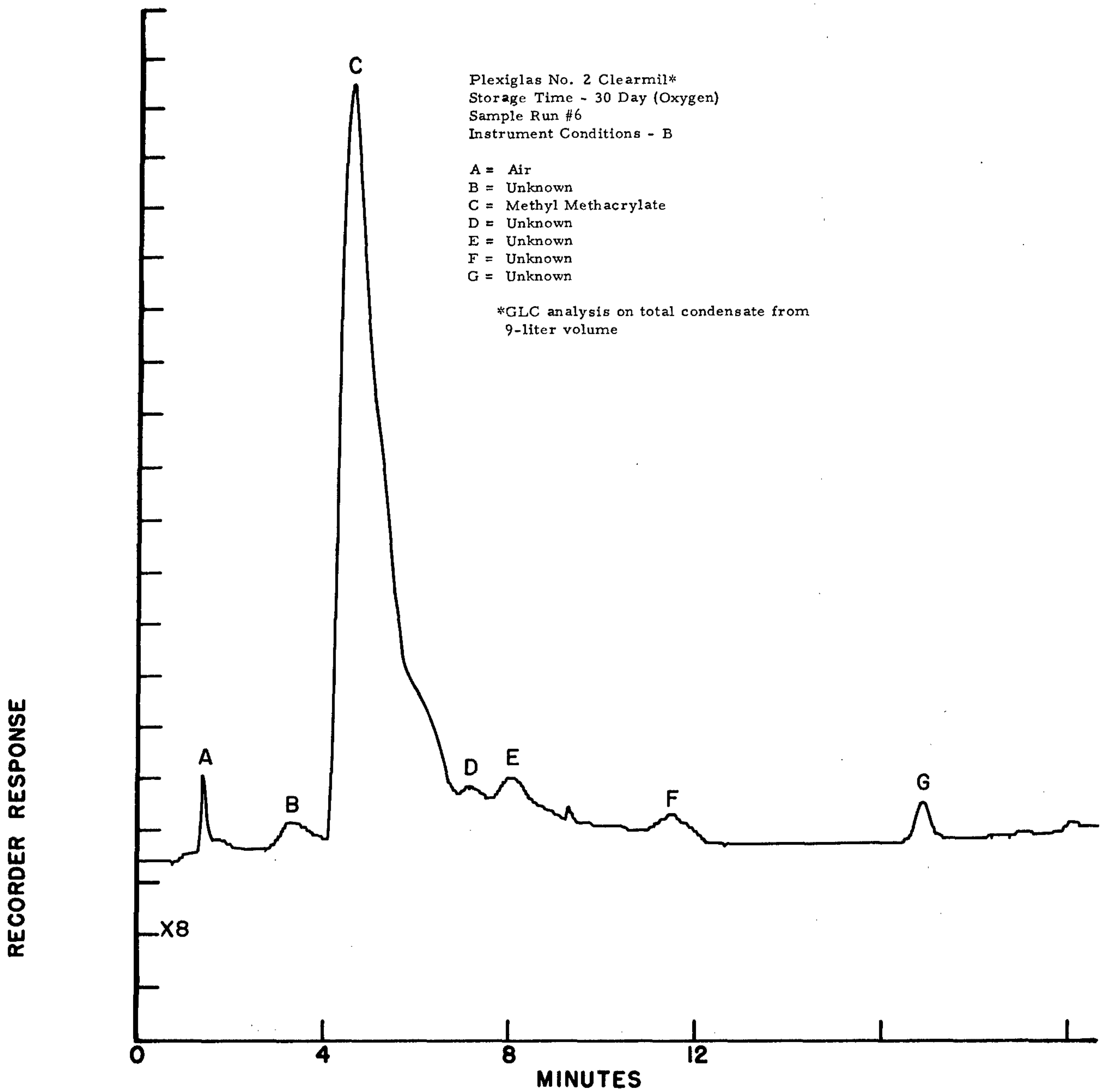


Figure 40. Gas Chromatogram of Gas-Off Products from Plexiglas No. 2 Clearmil (30 Days, Oxygen).

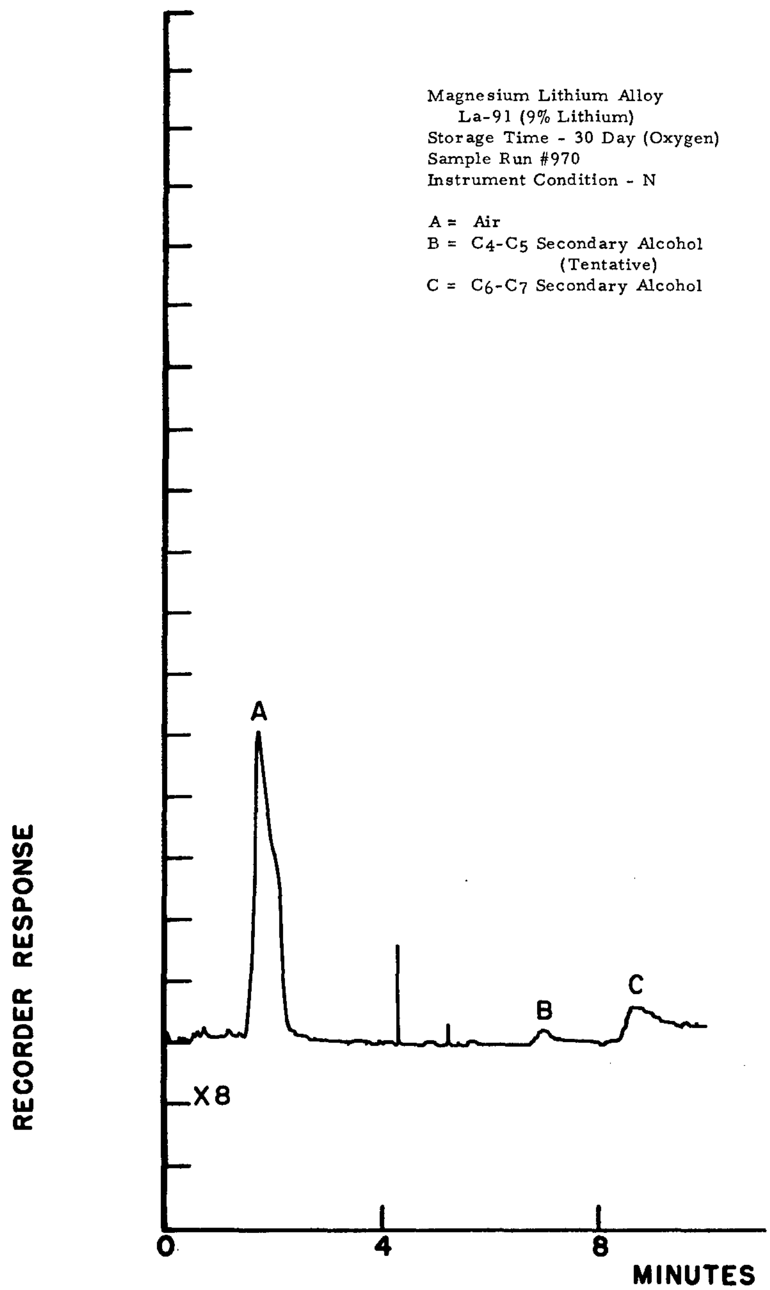


Figure 41. Gas Chromatogram of Gas-Off Products from Magnesium Lithium Alloy La-91 (9% Lithium) (30 Days, Oxygen).

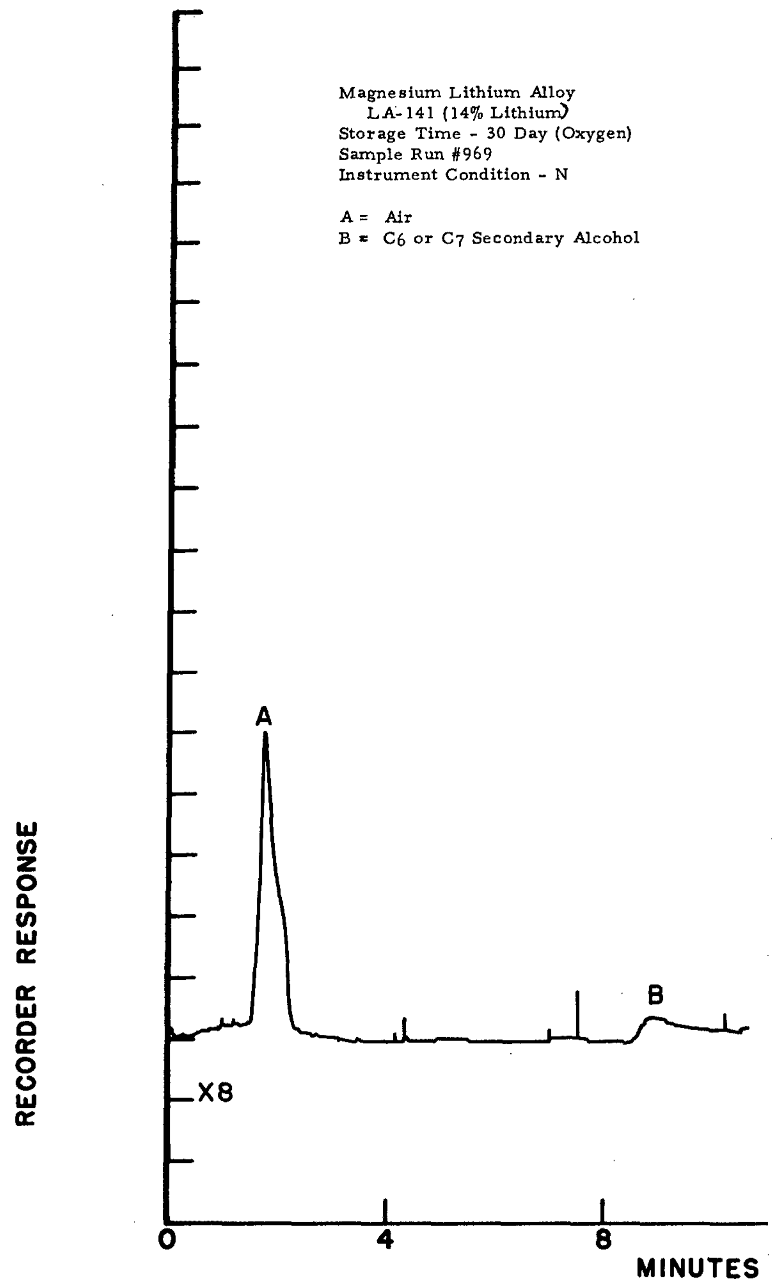


Figure 42. Gas Chromatogram of Gas-Off Products from Magnesium Lithium Alloy LA-141 (14% Lithium) (30 Days, Oxygen).

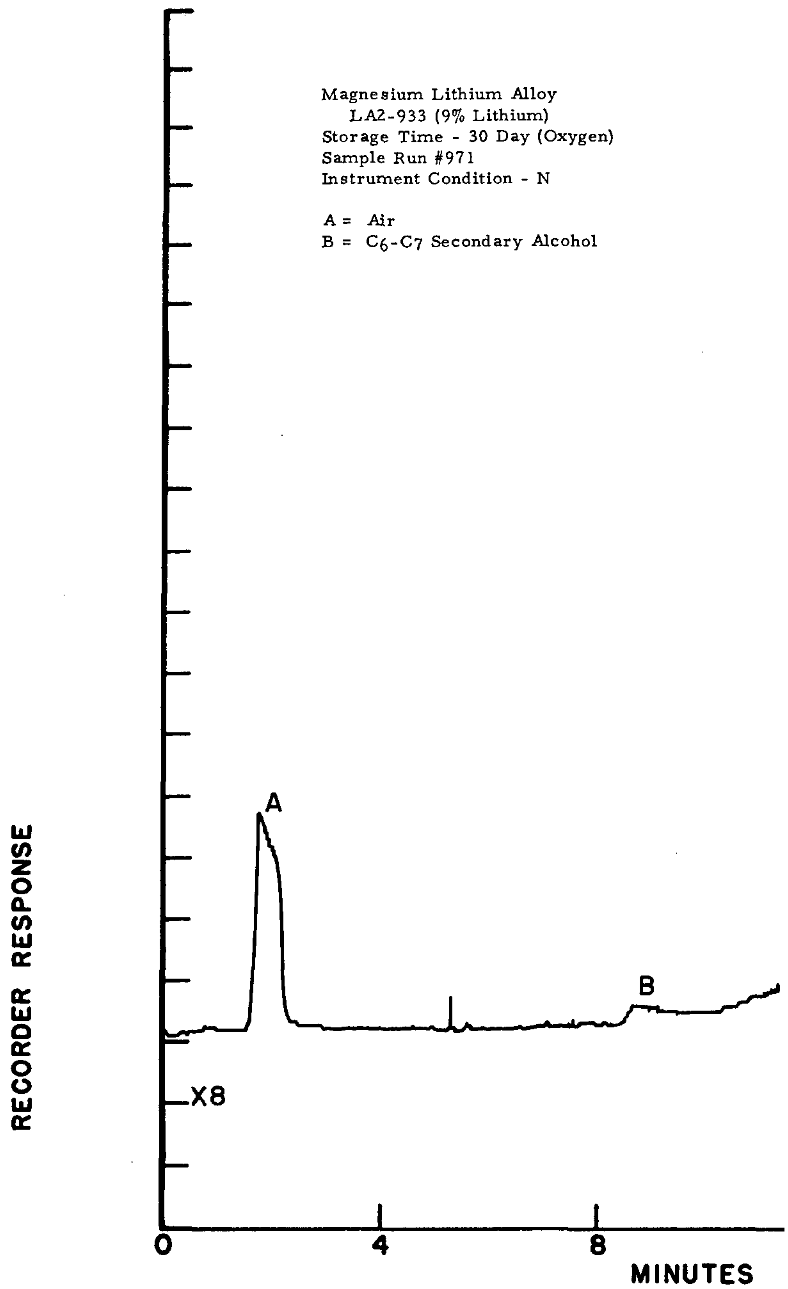


Figure 43. Gas Chromatogram of Gas-Off Products from Magnesium Lithium Alloy LA2-933 (9% Lithium) (30 Days, Oxygen).

APPENDIX IV

CARBON DESORPTION ANALYSES

AND

GAS CHROMATOGRAMS

The gas chromatograms shown in this appendix were obtained on F & M Scientific Corporation Model 300 and Model 500 Gas Chromatographs using thermal conductivity detectors with rhenium-tungsten filaments. Instrument conditions and column specifications are listed in Table XC.

Table XC

GAS CHROMATOGRAPHIC INSTRUMENT CONDITIONS FOR ANALYSIS OF CARBON DESORBATES

Condition		
O	Column temp. - 35° for 1 min; programmed @ 21°C/min. to 350°C	
	Detector temp. - 265°C	Injection port temp. - 310°C
	Flow Rate - 5 ml/min.	Filament current - 175 ma
	Chart speed - 0.5"/min.	Sample size - 1.0 ml (gas)
	Column - Linde Molecular Sieve 5A (2' x 1/4" stainless steel)	
P	Column temp. - 50°C	
	Detector temp. - 265°C	Injection port temp. - 310°C
	Flow Rate - 60 ml/min.	Filament current - 172 ma
	Chart speed - 0.5"/min.	Sample size - 0.2 μl
	Column - 10% Octoil S on Haloport F (10' x 1/4" copper)	
Q	Column temp. - 95°C	
	Detector temp. - 265°C	Injection port temp. - 310°C
	Flow Rate - 60 ml/min.	Filament current - 175 ma
	Chart speed - 0.5"/min.	Sample size - 0.2 μl
	Column - Carbowax 5000 on 60-80 mesh (6' x 1/4" stainless steel)	

Table XCI

ANALYSIS OF DESORBATE FROM CARBON CANISTER 10-12 DAY

Fraction	Weight (mg)	Mole Percent					
		CO_2	Water	Ethylene	Ethanol	Freon-12	Acetaldehyde
Volatile at -76°C	13.5[(1)]	81.7	6.2	9.5	-	1.5	1.1
Volatile at 0°C	13.1[(1)]	92.6	3.9	1.0	0.7	1.1	0.7
Volatile at 23°C	11.1[(1)]	64.6	10.8	-	13.9	0.5	10.2
Volatile at 100°C	467.5	0.2	85.8	-	12.7	-	1.3

(1) Determined by pressure-volume measurements

Table XCII

ANALYSIS OF DESORBATE FROM CARBON CANISTER 16-18 DAY

Fraction	Weight (mg)	Mole Percent						
		CO_2	Water	Ethylene	Ethanol	Freon 12	Acetaldehyde	Acetone
Volatile at -76°C	14.3[1]	97.3	0.2	1.9	-	0.6	-	-
Volatile at 0°C	14.1[1]	97.3	1.6	1.6	-	1.0	-	-
Volatile at 23°C	45.2	1.4	42.4	-	54.1	-	2.1	-
Volatile at 100°C	8.4	4.8	55.4	-	36.5	-	1.2	2.1

(1) Determined by pressure-volume measurement.

Table XCIII

ANALYSIS OF DESORBATE FROM CARBON CANISTER 26-28 DAY

Fraction	Weight (mg)	Mole Percent				
		CO_2	Water	Ethylene	Ethanol	Acetaldehyde
Volatile at -76°C	7.4(1)	98.1	1.0	0.9	-	-
Volatile at 0°C	13.6	98.7	1.3	-	-	-
Volatile at 23°C	not determined	0.7	35.6	-	62.6	1.1
Volatile at 100°C	406.4	0.4	92.3	-	7.2	0.1

(1) Determined by pressure-volume measurement

Table XCIV

ANALYSIS OF DESORBATE FROM CARBON CANISTER 28 DAY (THOMAS)

Fraction	Weight (mg)	Mole Percent						
		CO_2	Water	Ethylene	Ethanol	Freon-12	C_3 Hydrocarbon	Acetaldehyde
Volatile at -76°C	20-30[1]	82.6	0.1	16.6	-	0.4	0.2	-
Volatile at 0°C	18[1]	93.0	0.1	5.4	0.3	0.4	0.7	-
Volatile at 23°C	36.2	-	79.3	-	19.7	0.9	-	-
Volatile at 100°C	872.5	-	63.3	-	36.2	-	-	0.5

(1) Determined by pressure-volume measurements

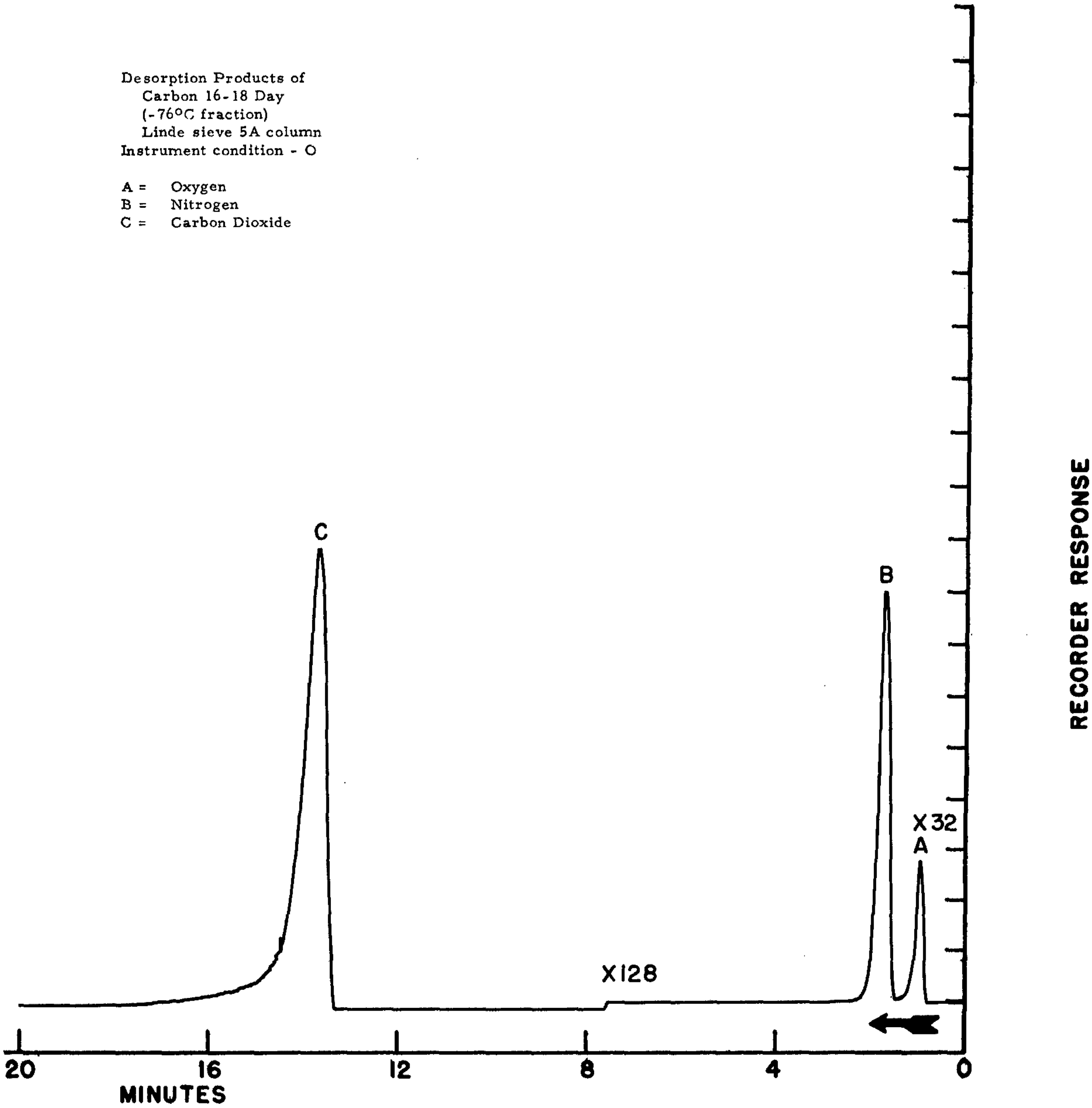


Figure 44. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (-76°C Fraction).

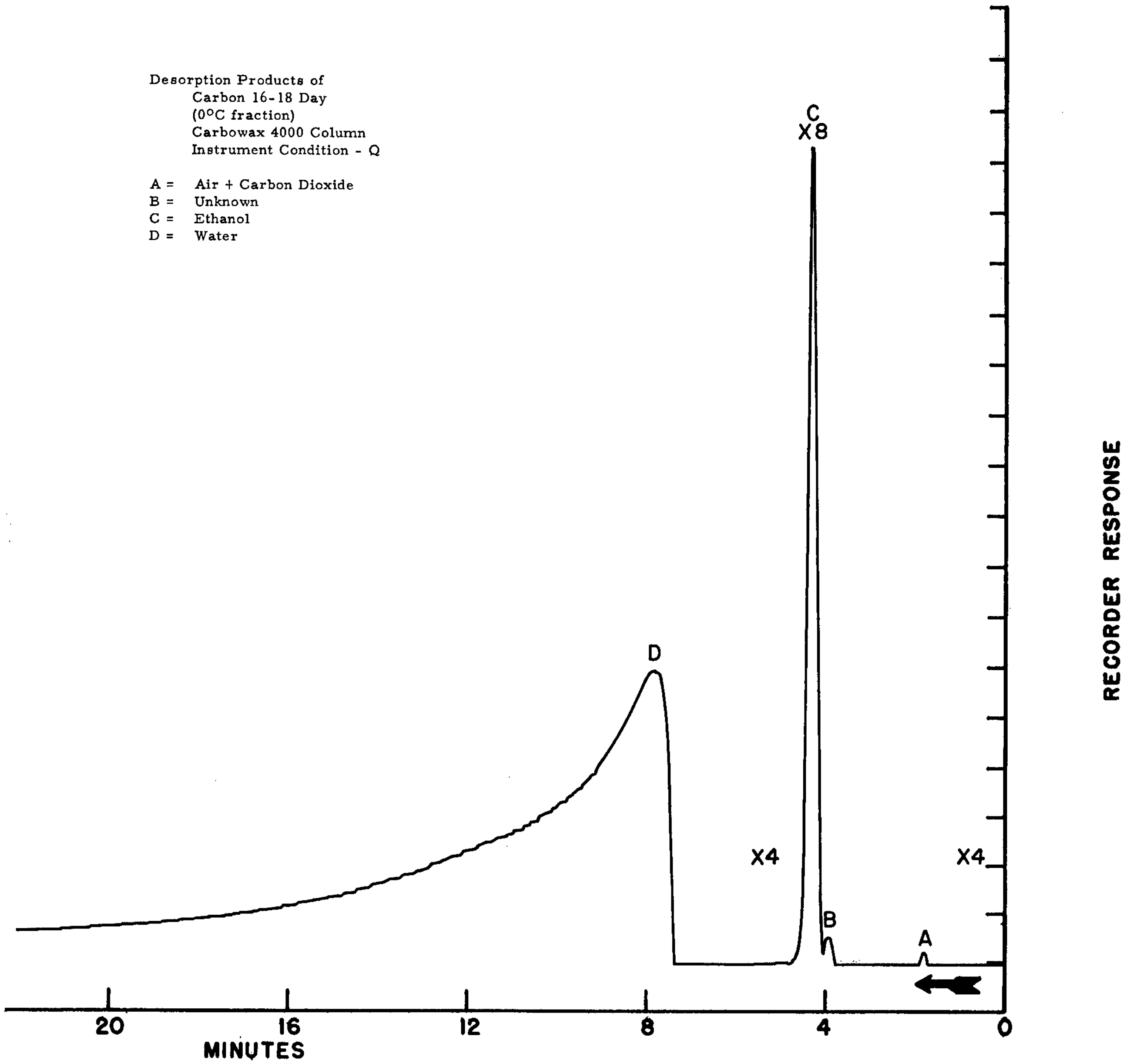


Figure 45. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (0°C Fraction).

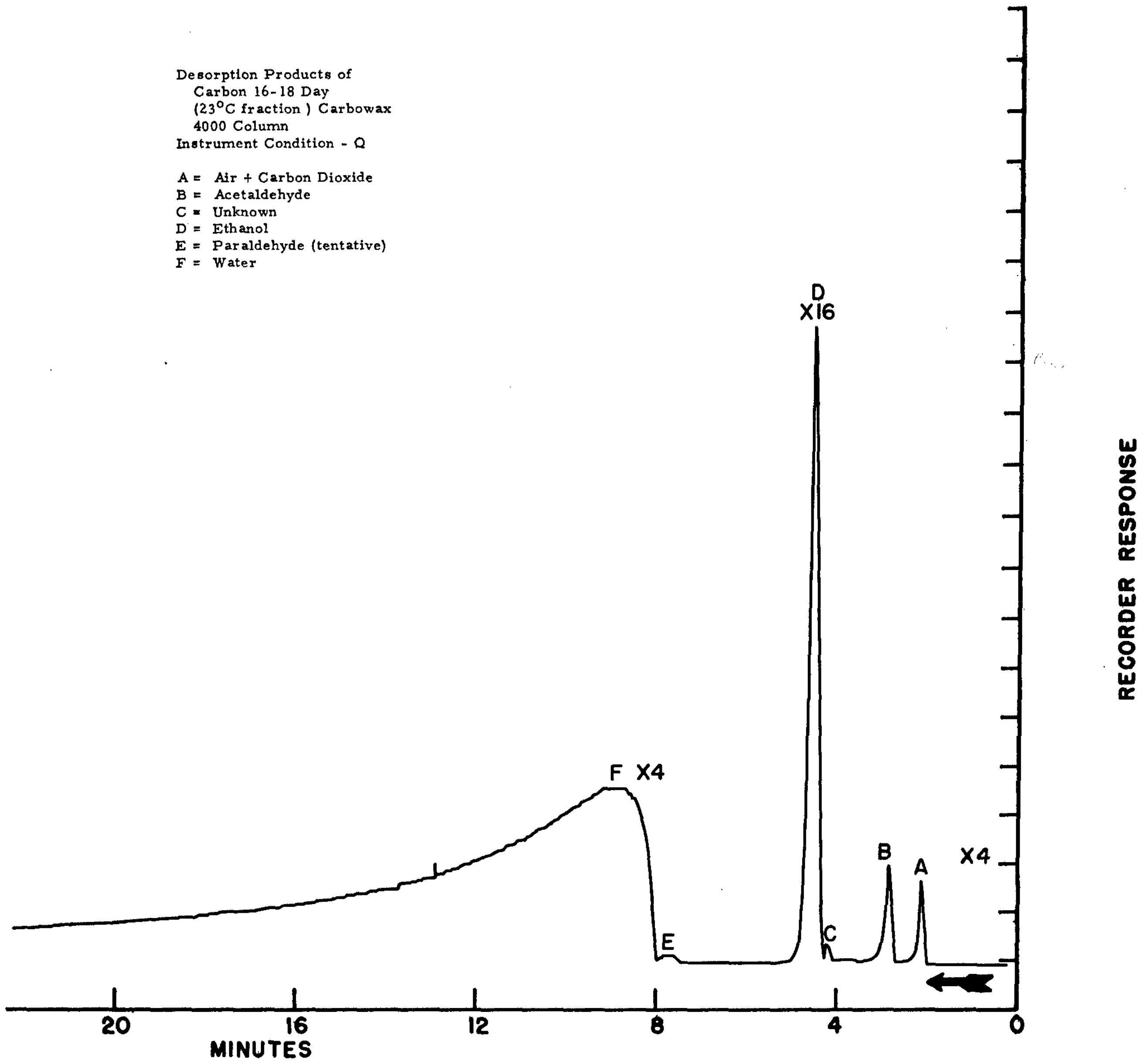


Figure 46. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (23°C Fraction) Using Carbowax 4000 Column.

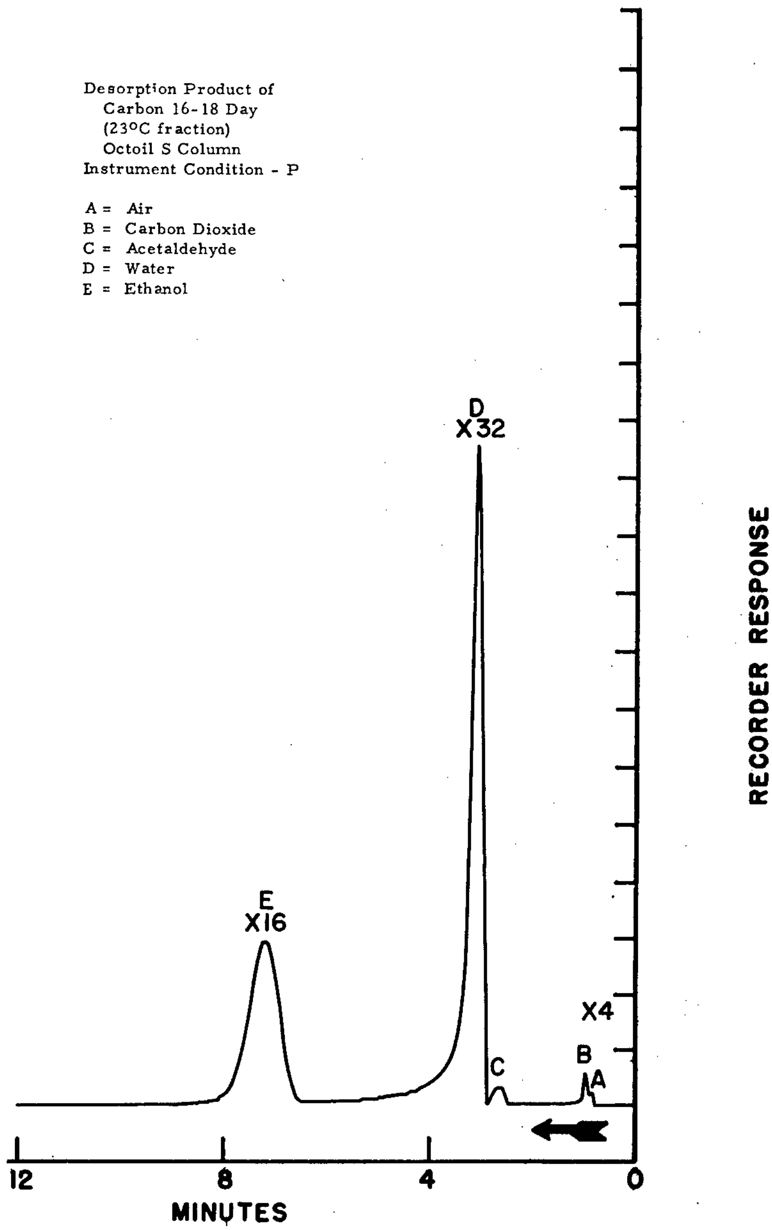


Figure 47. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (23°C Fraction) Using Octoil S Column.

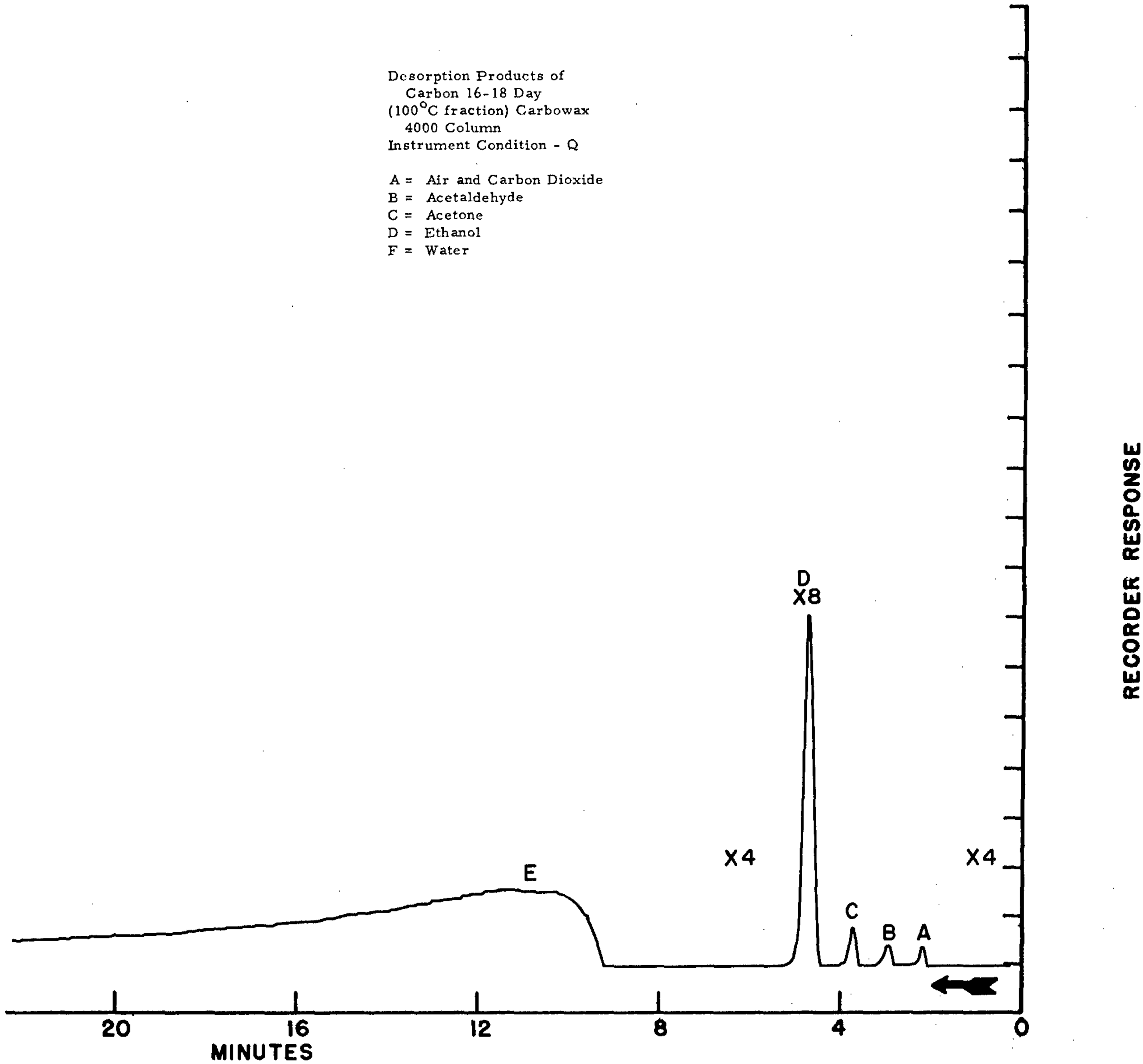


Figure 48. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (100°C Fraction) Using Carbowax 4000 Column.

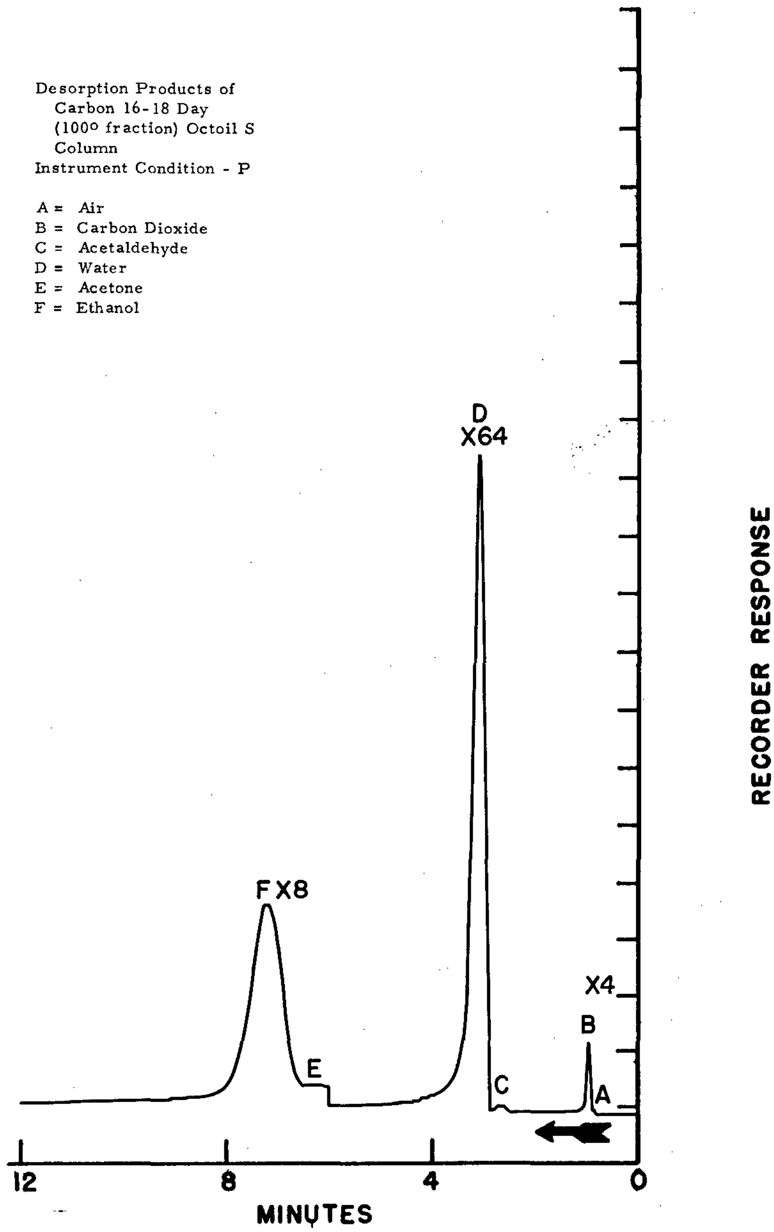


Figure 49. Gas Chromatogram of Desorption Products of Carbon 16-18 Day (100°C Fraction) Using Octoil S Column.

APPENDIX V

ANALYTICAL DATA

FOR

HYDROLYSIS OF MCS 198

The gas chromatograms shown in this appendix were obtained on F & M Scientific Corporation Model 300 and Model 500 Gas Chromatographs using thermal conductivity detectors with rhenium-tungsten filaments. Instrument conditions and column specifications are listed in Table XCV.

Table XCV

GAS CHROMATOGRAPHIC INSTRUMENT CONDITIONS FOR ANALYSIS OF HYDROLYSIS PRODUCTS OF MCS 198

Condition

R

Column temp. - 50°C held for 7 min. 40 sec. then programmed @ 6.5°C/min. to 200°C.
Detector temp. - 260,C Injection port temp. - 315°C
Flow Rate - 60 ml/min. Filament current - 175 ma
Reference Flow Rate - 50 ml/min.
Chart speed - 0.5"/min. Sample size - 0.1 µl
Column - 20% SGR on 60-80 mesh Gas Chrom P
(11' x 1/4" stainless steel)

Table XCVI

MCS 198 + LiOH IN ATMOSPHERE OF 35% RELATIVE HUMIDITY

Contact Time (hrs)	Weight of Condensables (mg)	Composition of Condensables by GLC (% of Total Peak Area)						
		Water	2-Propanol	2-Butanol	$Si(OIP)_4$	$Si(OIP)_3(OSB)$	$Si(OIP)_2(OSB)_2$	$Si(OIP)(OSB)_3$
1[a]	47.5	72.4	19.6	8.0	-	-	-	-
1 + 5[a]	24.3	58.8	27.8	12.1	0.6	0.6	0.1	-
1 + 5 + 18[a]	26.7	19.9	55.6	18.5	2.1	2.8	1.1	trace
6	30.2	69.9	22.6	7.5	-	-	-	-
24	127.0	trace	71.7	23.4	2.1	2.4	0.4	-
24 (Blank)[b]	36.5	59.3	23.8	13.1	1.5	1.7	0.6	trace
24 (Water)[c]	140.0	trace	64.2	13.8	7.3	9.8	4.9	-

[a] After removing head gases, flask was recharged and progressive analyses were performed.

[b] No LiOH.

[c] Three Milliliters of water added to LiOH.

IP - Isopropyl
SB - Secondary butyl

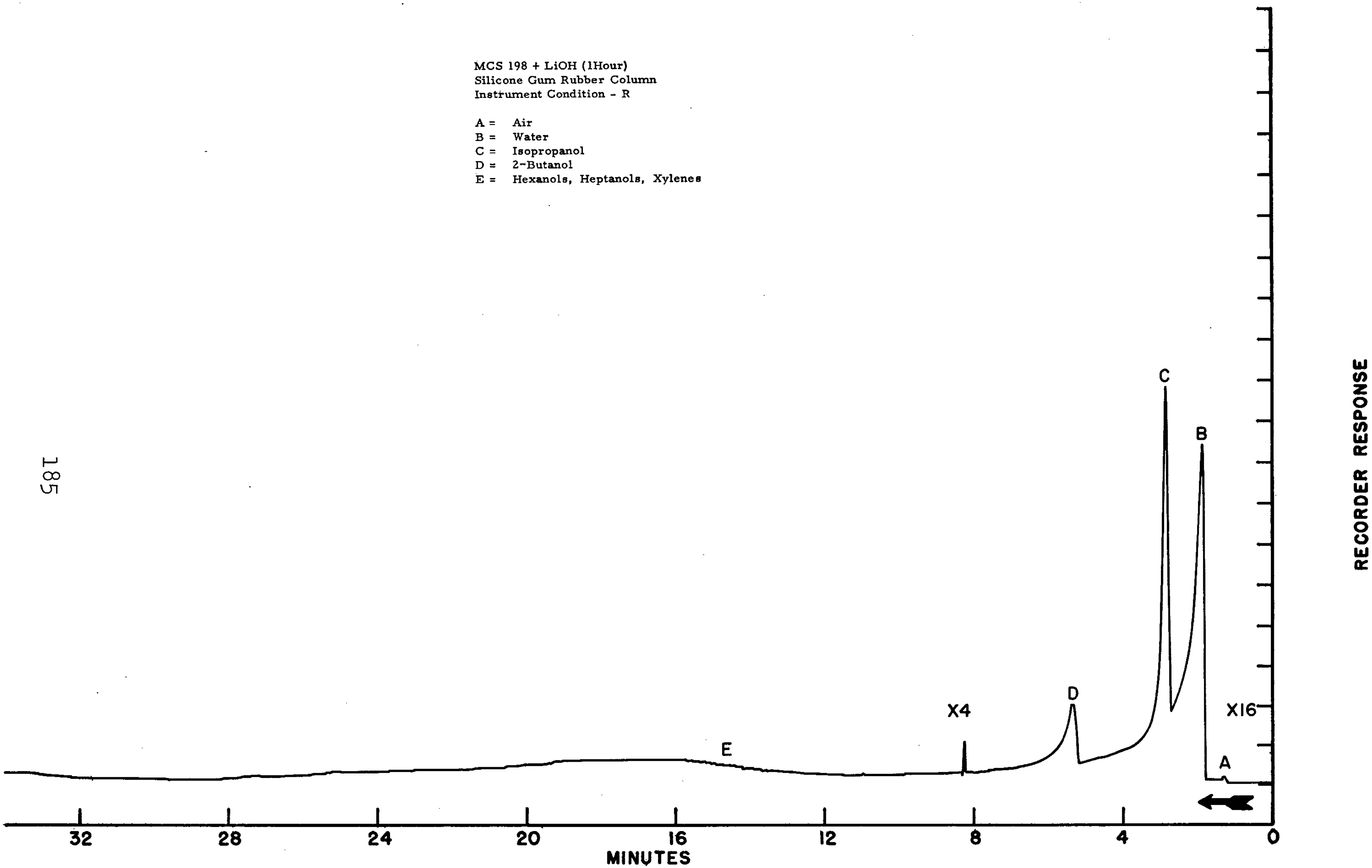


Figure 50. Gas Chromatogram of Gaseous Product from MCS 198 and LiOH (1 hour).

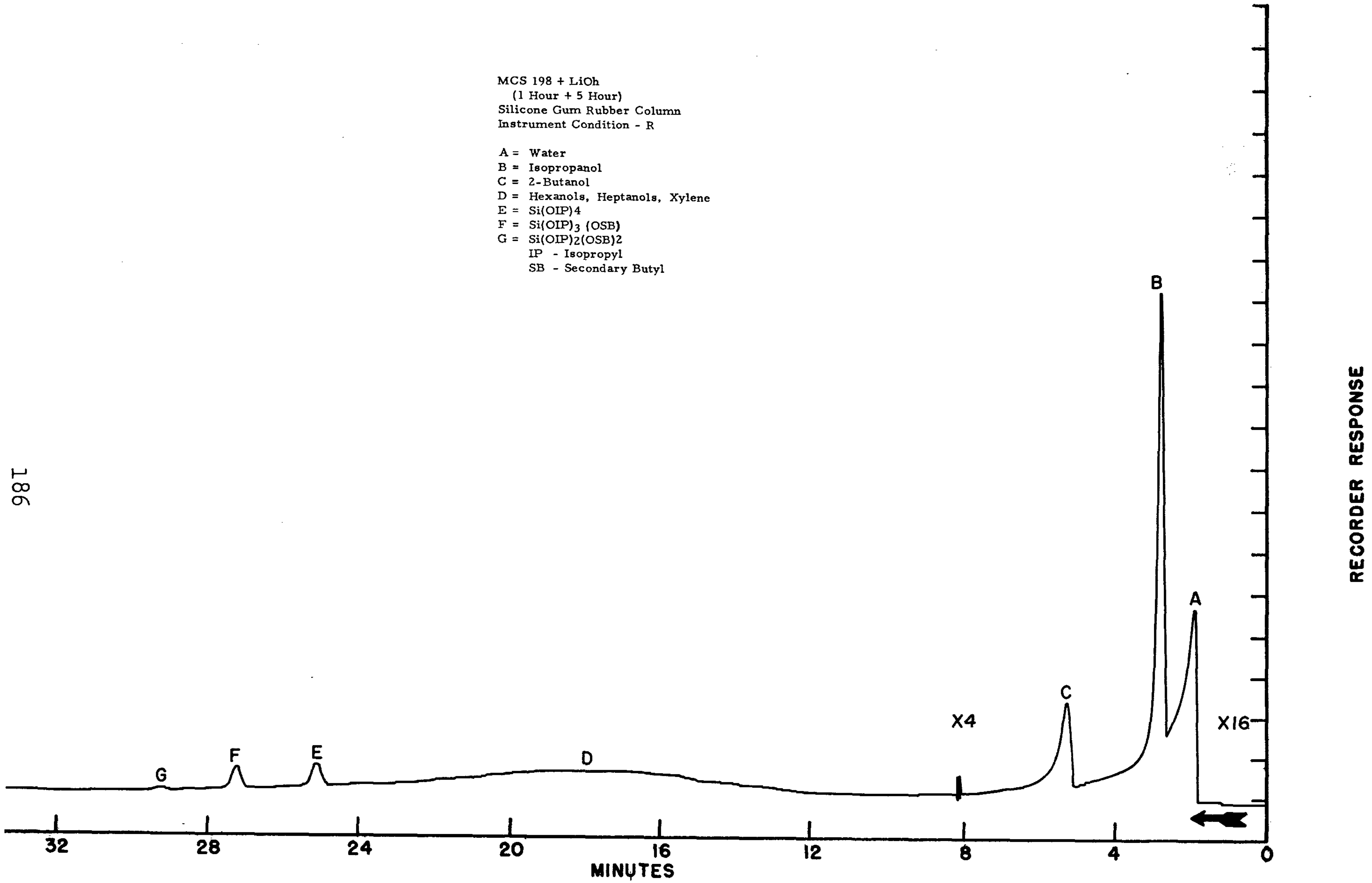


Figure 51. Gas Chromatogram of Gaseous Product from MCS 198 and LiOH (1 hour + 5 hours).

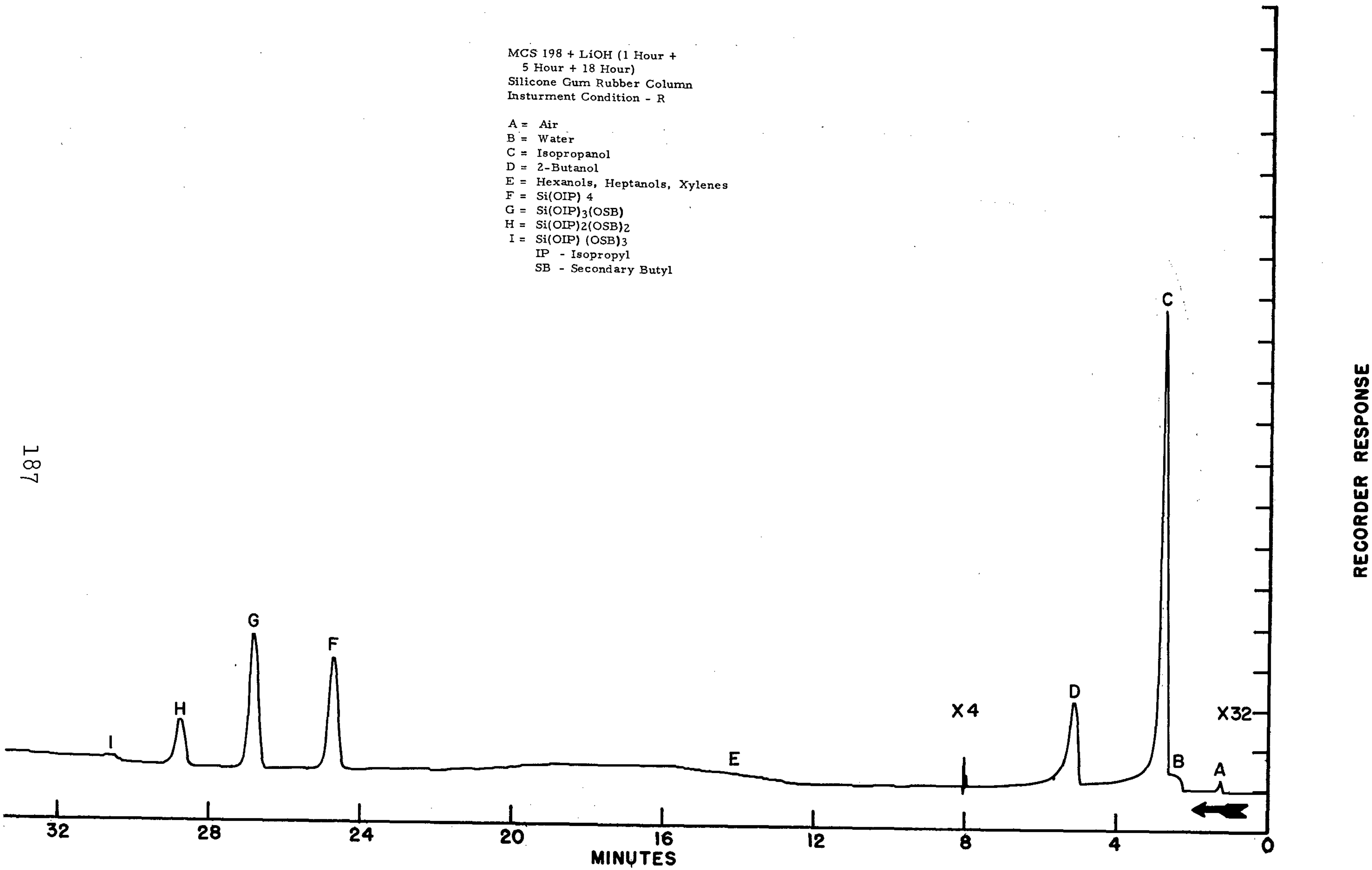


Figure 52. Gas Chromatogram of Gaseous Product from MCS 198 and LiOH (1 hour + 5 hours + 18 hours).

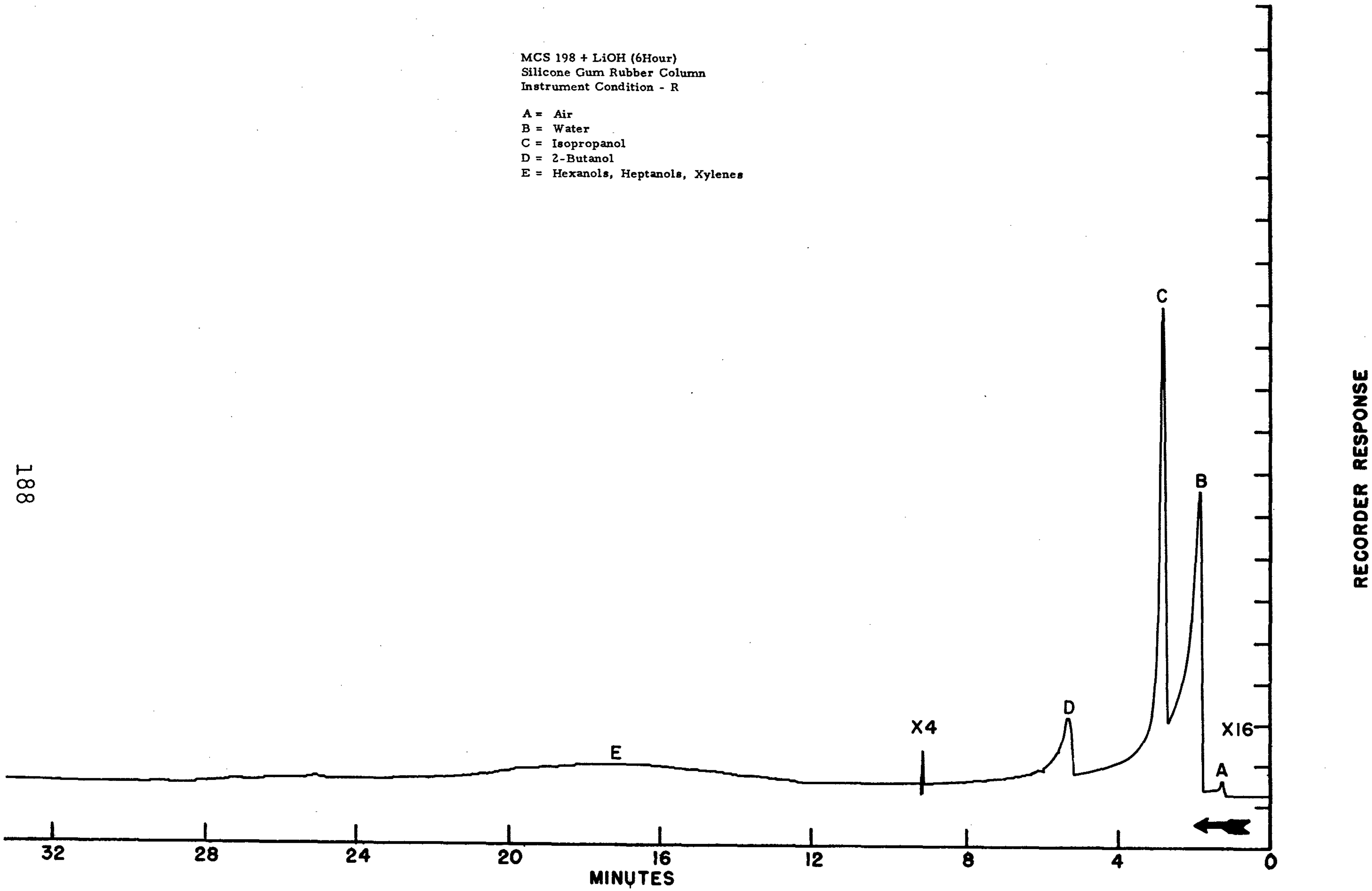


Figure 53. Gas Chromatogram of Gaseous Product of MCS 198 and LiOH (6 hours).

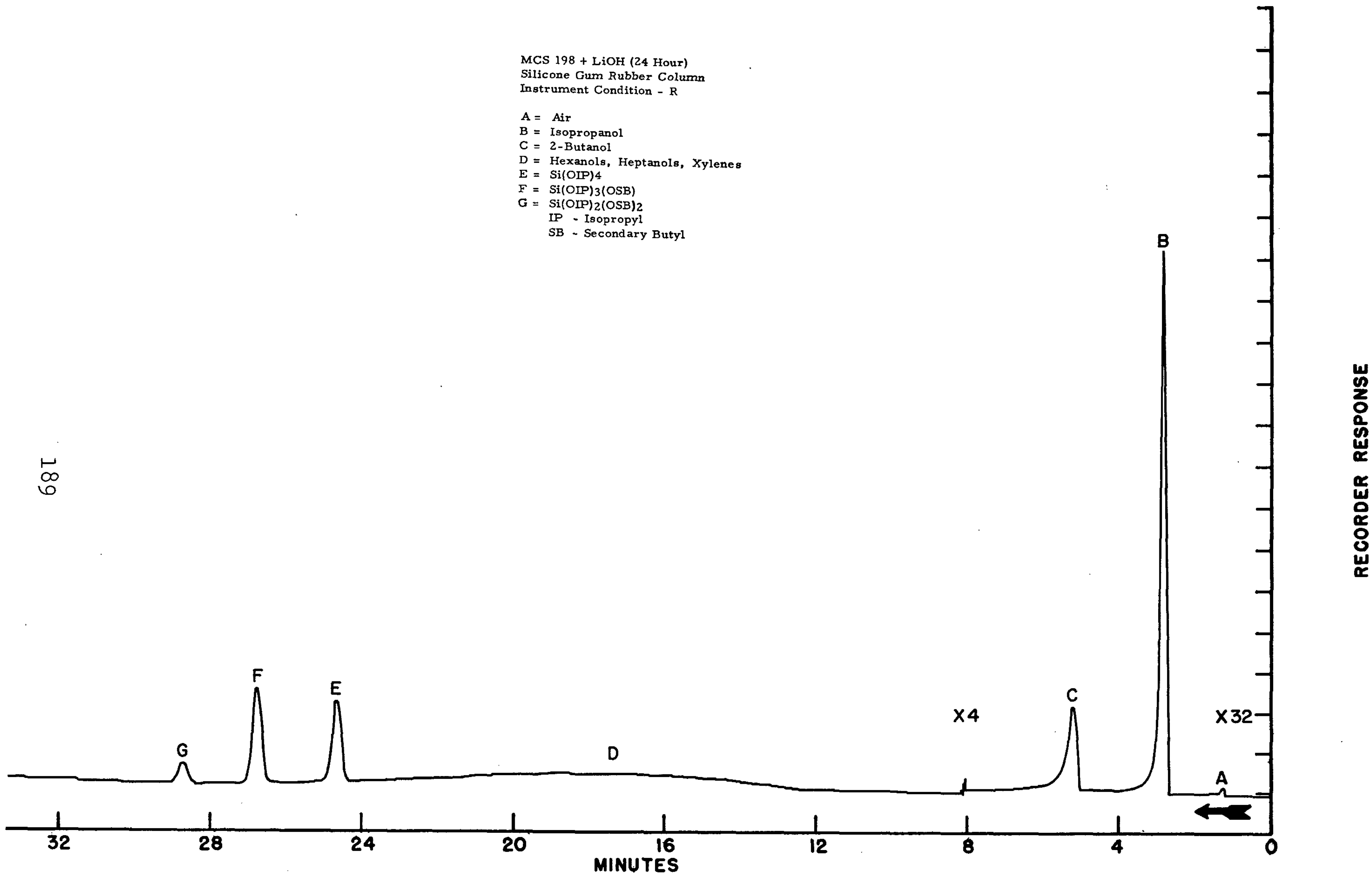


Figure 54. Gas Chromatogram of Gaseous Product of MCS 198 and LiOH (24 hours).

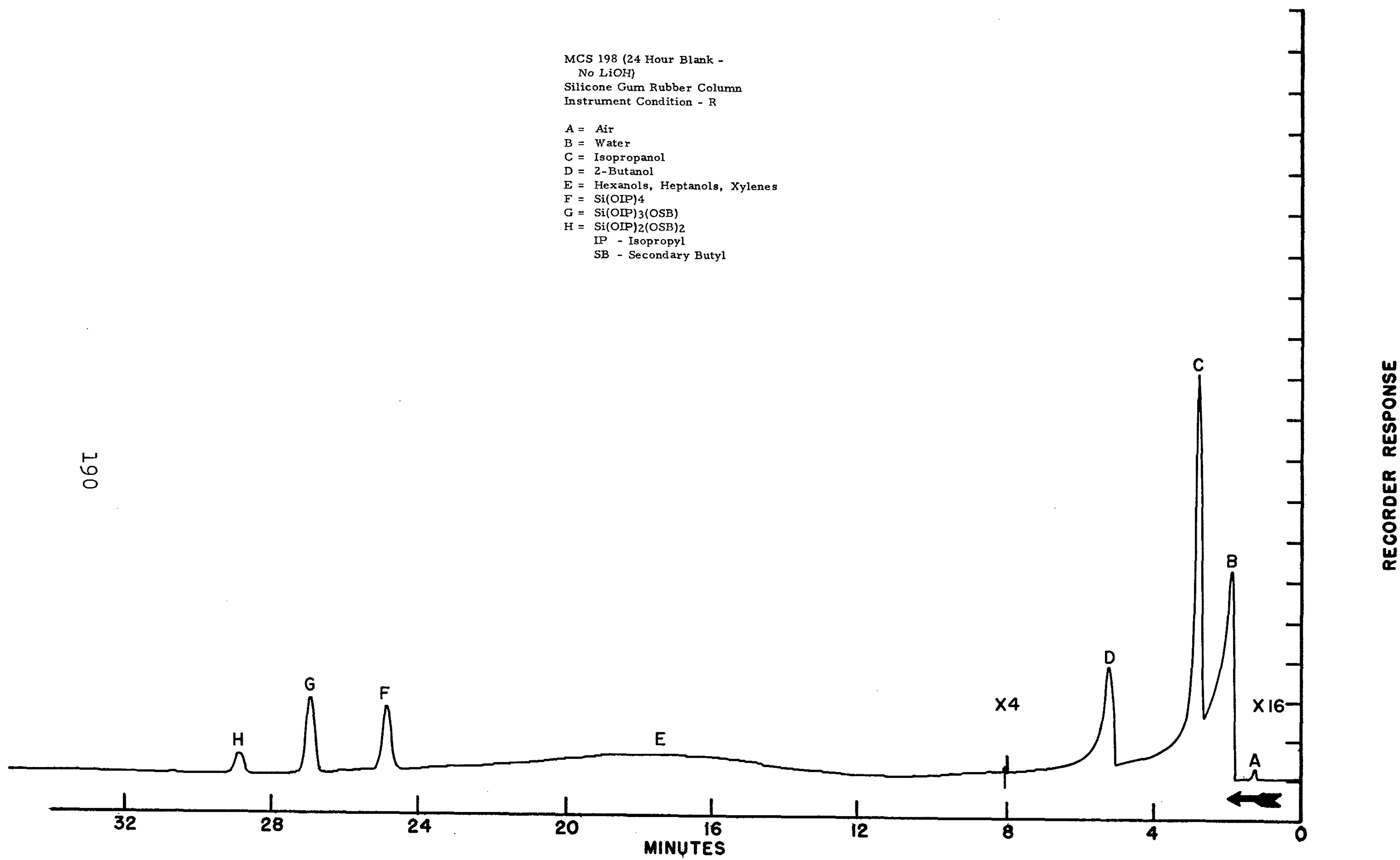


Figure 55. Gas Chromatogram of Gaseous Product from MCS 198 (24 hour Blank - no LiOH).

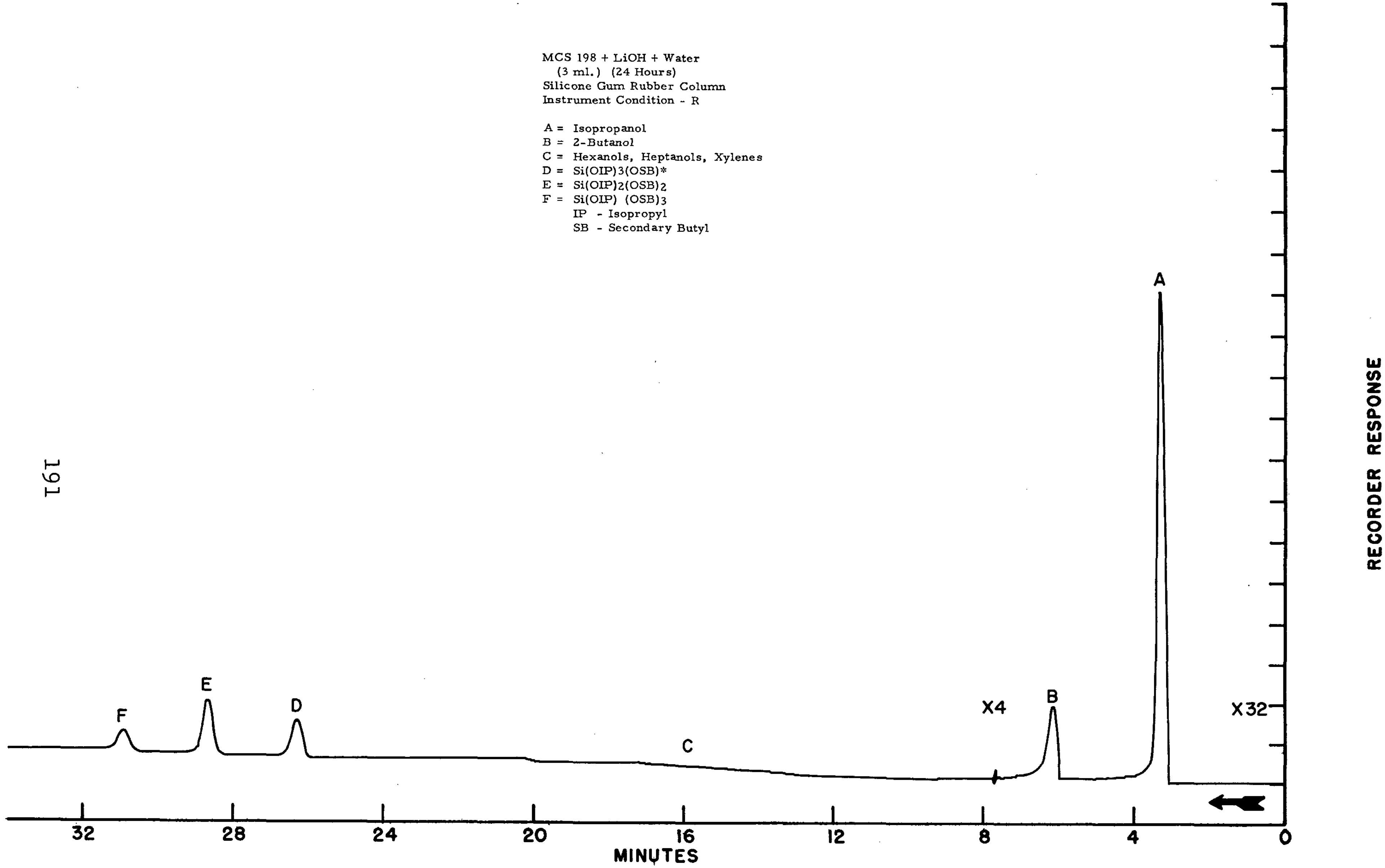


Figure 56. Gas Chromatogram of Gaseous Product of MCS 198, LiOH and Water (24 hours).

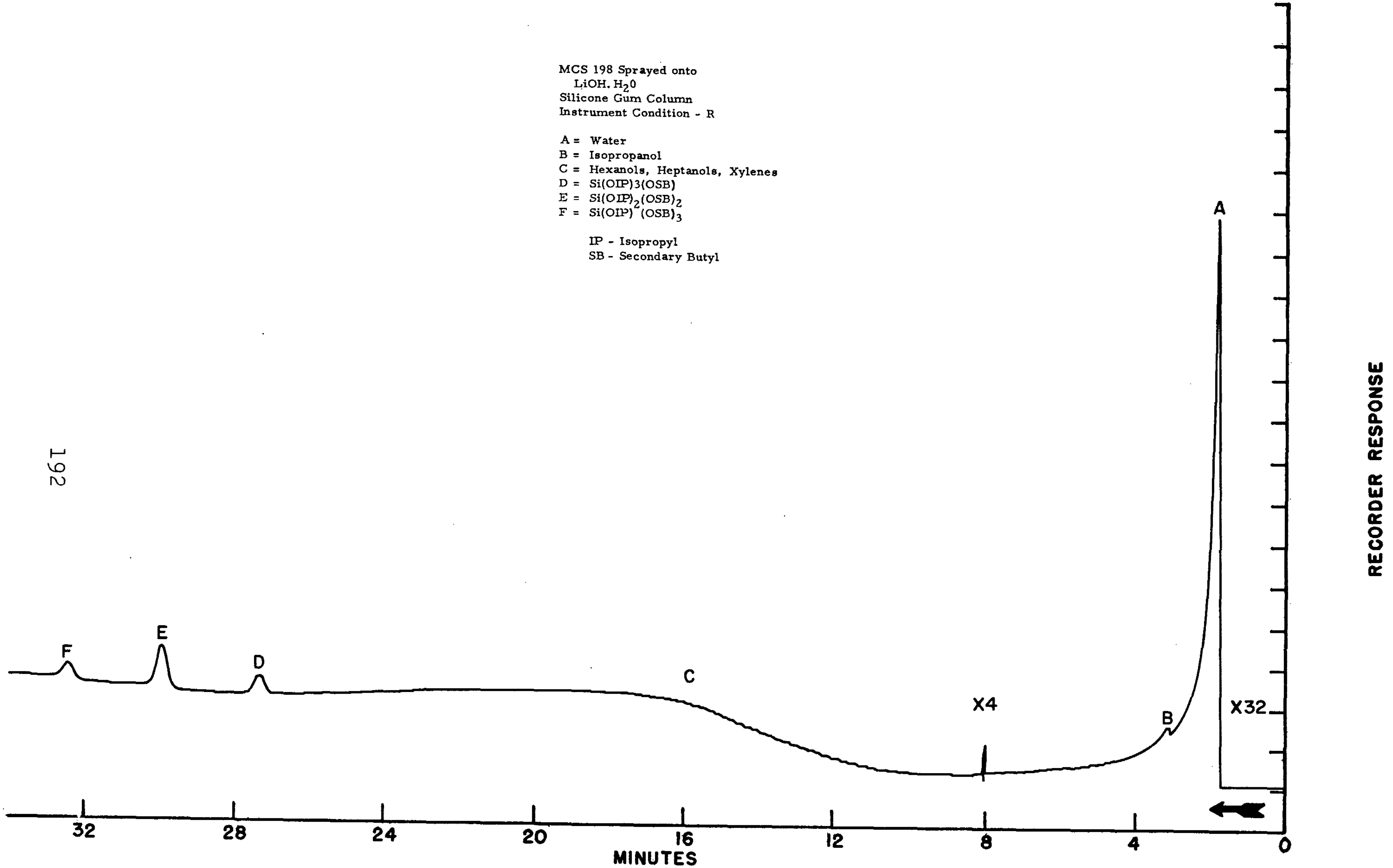


Figure 57. Gas Chromatogram of Gaseous Product from MCS 198 Sprayed onto $LiOH \cdot H_2O$.

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13. ABSTRACT

Fifty-five candidate materials for space cabin construction were stored for 30, 60, and 90 day periods at 23-25°C, and 20-40% R.H. in environments of air at a pressure of one atmosphere and oxygen at 5 psia. The composition of the gas-off products were determined by mass spectrometry and gas chromatography.

Additional analyses were performed on desorbates from four carbon canisters from space cabin simulators and the hydrolysis products of MCS 198.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Space cabin candidate materials Volatile contaminant analyses Mass spectrometry Gas chromatography						

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